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CONTENTS

	Page
chnical Education and Industry	547
mpon Savage Life. By the Right Hon. Lord Raglan	548
e Substitutional Calculus of Alfred Young. By Dr. A. C. Aitken, F.R.S.	549
rds of a Great Metropolis. By R. M. Lockley	549
ell's "First Garden Book". By G. E. Fussell	550
clear Forces. By Prof. M. H. L. Pryce	550
orld Food and World Population	553
ndon's Water-Supplies. By Prof. H. L. Hawkins, F.R.S.	554
e Impact of Science on Society	555
ectronic Calculating-Machine Development in Cambridge. By Dr. M. V. Wilkes	557
Obituaries:	
Sir Frederick W. Moore. By Dr. R. Lloyd Praeger	559
Dr. F. E. Whitmore	559
ws and Views	559
st International Congress of Biochemistry	563
e Gap Between Science and Industry	565
chnology and the Humanities	566
nversion of Mannitol and Sorbitol into Dulcitol. By Dr. P. Bladon, Dr. L. N. Owen, Dr. W. G. Overend and Dr. L. F. Wiggins	567
ion Observations of Solar Radiation at a Wave-length of 50 cm. By W. N. Christiansen, D. E. Yabsley and B. Y. Mills	569
verage United Kingdom Trust: Annual Report	570
ecting Men of Science	571
tters to the Editors:	
Wind and Temperature Measurements up to 30 Km.—Dr. F. J. Scrase	572
Crystal Size and Fluorescence Intensity.—E. J. Bowen, F.R.S., and P. D. Lawley	572
Interconversion of Dianhydro Hexitols and of Saccharic Acids.—V. G. Bashford and Dr. L. F. Wiggins	573
Application of Halogeno-Ketones to the Synthesis of Pteridines, including Pteroic Acid.—Prof. F. E. King and P. C. Spensley	574
Synthesis of the 8z-Chloro-indoles.—Dr. H. N. Rydon and C. A. Long	575
Hiptagenic Acid Identified as β-Nitropropionic Acid.—C. L. Carter and W. J. McChesney	575
A New Method for Forming Vinyl Polymers in Wool.—Dr. M. Lipson	576
A New Method of Peptide Synthesis.—H. Chantrenne	576
Further Studies on 3:4 Benzxanthenes.—Dr. Munir Gindy	577
Distinction of Vermiculite, Chlorite and Montmorillonite in Clays.—Dr. G. F. Walker	577
Parahydrogen Catalysis by Transition Metals.—A. Couper and Dr. D. D. Eley	578
Absorptiometric Determination of Uranium.—A. A. Smales and E. Furby	579
Pyrophosphatase Activity of Brain Tissue.—Dr. J. J. Gordon	579
Endogenous Formation of Carbon Monoxide in Man.—Torgny Sjöstrand	580
Continuous Recording of Sensory Thresholds and Other Psycho-Physical Variables.—R. C. Oldfield	581
Anisotropic Permanent Magnetic Alloys.—Dr. K. Hoselitz and Dr. M. McCaig	581
A Room-Temperature Transition in Polytetrafluoroethylene.—H. A. Rigby and C. W. Bunn	583
Raman and Infra-Red Spectra of β-Quartz.—Bishambhar Dayal Saksena and Hari Narain	583
Discontinuous Flow Phenomena in Gelatine Gels.—V. R. Gray	584
Use of Aspherical Surfaces in the Design of Magnifiers for Binocular Vision.—C. E. Coulman and G. R. Petrie	586
Life-time for Pair Emission by Spherically Symmetrical Excited State of the O^{16} Nucleus.—Dr. S. Devons, H. G. Hereward and G. R. Lindsey	586
Subsurface Crypts, Oogenesis, and the Corpus Luteum in the Ovaries of Seals.—Dr. L. Harrison Matthews and Dr. R. J. Harrison	587
Magnetic Storms and Cosmic-Ray Intensity.—Dr. H. R. Sarna and Om Parkash	588
Discovery of Neolithic Polished Bone Axe-Heads in Africa.—A. J. Arkell, M.B.E.	589
Thermal Conductivity of Powders.—Prof. Z. Klemensiewicz	589

TECHNICAL EDUCATION AND INDUSTRY

IN some respects the discussion which followed Sir Arthur Fleming's presidential address to Section G (Engineering) of the British Association at the recent meeting at Newcastle upon Tyne was disappointing (see p. 565 of this issue); nevertheless, Sir Henry Tizard, in concluding the discussion, threw out suggestions which, it is to be hoped, will be taken up by the Chemistry Section, as well as by the Engineering and Economics Sections, to which in particular he referred. The apparent reluctance of some large industrial units which maintain their own organisations for research and development to embark on adventurous projects is attributed by some to the deterrent effect of fiscal laws; other reasons were indicated earlier in the discussion, notably by Sir Claud Gibb. But, while Sir Henry himself expressed no opinion on the matter, he suggested that it is one that could usefully be discussed at a joint meeting between the Engineering Section and the Economics Section, as well as the related question of the capital equipment of British industry and its rate of obsolescence, and their bearing on the ability and readiness to finance new and unproved developments and processes.

These subjects have, indeed, been discussed over a period of years. The matter was examined by the Parliamentary and Scientific Committee, by the London Chamber of Commerce, by the Industrial Research Committee of the Federation of British Industries, as well as by the Internal Combustion Engine Manufacturers' Association, even before Sir John Anderson in his Budget speech in 1944 introduced a special allowance for new plant and machinery, and modified the distinction drawn for income tax purposes between capital and revenue expenditure on research. A useful memorandum on taxation and research was issued in 1944 by the Parliamentary and Scientific Committee, while so far back as September 1943, *The Round Table* was urging an open-minded inquiry into the whole basis of taxation with the object of devising a system that will encourage, instead of penalize, the modernization of equipment.

Sir Alexander Gray's presidential address to Section F (Economics) can be taken as typical of the economist's contribution. More may come out of the joint discussion suggested by Sir Henry Tizard than emerged from the rather superficial examination of the question in some of the reports during the war years.

The discussion following Sir Arthur Fleming's address fastened on education as one of the keys to a solution, but without following out the implications. The importance of teachers in technical colleges and universities having some first-hand and up-to-date knowledge of industry was recognized; but no attempt was made to grapple with the obstacles to a free flow of men to and from teaching posts and industry, or to present constructive suggestions for overcoming the difficulties.

Had the further question been raised as to what university teachers, and how many, require a first-hand experience of industry, the discussion might have faced the more vital issues of the relations between the technical colleges and the universities of Great Britain, and the definition of their functions. It is surprising that not even the presence of the chairman of the Advisory Council on Scientific Policy led anyone to comment on the significant recommendation in the second annual report of the Council that the broad responsibility for higher technological education in this country should be transferred to the University Grants Committee. This recommendation represents an essential step towards achieving a sound and balanced national policy in higher technical education and university education, and inasmuch as strong support from professional bodies of scientific men and technologists will be essential if such a policy is to be implemented, it is disappointing to find that the importance of this recommendation was overlooked in this discussion.

Nor did the discussion evoke any comment on the observations in a recent statement from Nuffield College on the problems facing British universities regarding the slender claims of much technical and professional training to a place in the university curriculum. If a halt is to be called in the practice of expecting the universities to provide an infinite variety of vocational training, constructive alternative proposals must be formulated. To decide that the universities' part is primarily the study and teaching of the fundamental sciences which underlie professional studies or technology, and that industry should look to them essentially for the few who possess outstanding ability for pioneering research or leadership, will leave us with the problem of deciding where and how the training of the large number of technicians is to be conducted.

If the training of technical workers is properly a matter for the technical colleges, both professional bodies and industry will have a vital contribution to make in considering the large and wisely planned expansion required. Industry in particular must not only be prepared to assist by the provision of teachers with first-hand industrial experience, and by deciding on the numbers and types of such scientific workers and technicians it can employ; it must also be prepared to consider how far some at least of the technical training can be given within industry itself. Here again the problem of the small firm may present difficulties, and it may be found that the research associations can render further service by making possible the training of staff for such firms under conditions which confer a wider outlook and range of experience than is possible within a single small firm.

For such reasons as these, it is to be hoped that the discussion on bridging the gap between science and industry initiated in the Engineering Section of the British Association during the Newcastle upon Tyne meeting will be taken a stage further. The whole question of technical training and of the functions of technical colleges and the universities requires re-examination, and critical and informed discussion is a matter of urgency, both from the point of view of industrial productivity and of university expansion and the appropriate use of scientific man-power in Great Britain. Determination of the proper balance between the technical colleges and the universities might well relieve the universities of work that does not properly belong to them and endangers the maintenance of standards, and the long-term contribution to industrial efficiency may be as important as the immediate alleviation of acute problems in university expansion. Whatever its deficiencies, this discussion at Newcastle left no one who was present in any doubt that both educational policy and taxation policy are important elements in both industrial enterprise and efficiency.

ESSAYS ON SAVAGE LIFE

Magic, Science and Religion and other Essays

By Bronislaw Malinowski. Selected and with an introduction by Robert Redfield. Pp. xii+327. (Glencoe, Ill.: The Free Press; London: George Allen and Unwin, Ltd., 1948.) 18*s.* net.

BEFORE his sudden death in 1942, Malinowski had spent three years in the United States, and this selection of his essays hails from the University of Chicago. They do not always show their author at his best, for the vivid descriptions of savage life which made his books so deservedly successful are subordinated to generalizations, often made on insufficient data.

"The criticism often levelled at Malinowski," says the editor, "that he generalized from a single case, loses much of its force if the assumption be admitted that there are a common human nature and a universal culture pattern." While admitting the former we must deny the latter; the culture pattern of the Trobrianders is in many respects unusual and in some perhaps unique. Yet they were the only people among whom Malinowski did any extensive field-work, and throughout the present book he uses them as the sole exemplar of his theories.

In the first essay, that on "Magic, Science and Religion", he describes some Trobriand rites, enunciates such dogmas as that "monogamous marriage has always existed in human societies", and says that magic consists of acts which are means to definite ends, whereas religious acts are ends in themselves. This may be true in the Trobriands but is certainly not so elsewhere.

In the next essay, that on "Myth in Primitive Psychology", he again depends entirely on Trobriand material; but we can agree with him that myth "in its living primitive form, is not merely a story told but a reality lived".

The longest essay is on "Baloma; the Spirits of the Dead in the Trobriand Islands". In this, Malinowski describes his methods of field-work, and makes the highly controversial assertion that according to the Trobrianders the father is physically unrelated to his child.

In "Meaning in Primitive Languages", having learnt that English words seldom have an exact equivalent in the Trobriand language, that words often change their meaning with their context, and that colloquialisms can be understood only by those familiar with the circumstances in which they are used, he

puts forward a theory of language which ignores the main problem, namely, the origin of grammatical forms, which are often more complex in unwritten than in written languages.

In his "Analysis of War", he points out that aggressive behaviour is usually displayed within the group, whereas war is a conflict between two separate groups. Savage warfare, engaged in at first to obtain sacrificial victims, and later for loot, is usually unaccompanied by any feelings of enmity towards those attacked. In this essay, as in some of the others, he tends to overestimate the originality and importance of his discoveries; but all his writings, whether one agrees with them or not, are interesting and stimulating, and are written in excellent English.

There can be little doubt that Malinowski himself will be long remembered. By the enthusiasm of his teaching he was largely responsible for the advancement of anthropology in our universities. His "functional theory", though theoretically weak, has impressed upon students the fact that people do not move from one watertight compartment labelled "religion" to another labelled "family life". His insistence that in order to describe a rite it is not enough to take down an account of it from an informant, but that it is necessary both to witness it and to discuss it with the participants in their own language, has greatly improved the standards of field-work. Finally, he has brought home to the general reader the fact that savages are not "half devil and half child", but are human beings very much like ourselves.

RAGLAN

THE SUBSTITUTIONAL CALCULUS OF ALFRED YOUNG

Substitutional Analysis

By Dr. Daniel Edwin Rutherford. (Edinburgh University Publications, Science and Mathematics, No. 1.) Pp. xi+103. (Edinburgh: University Press; and Oliver and Boyd, 1948.) 25*s*. net.

THE work of the late Dr. Alfred Young is now more widely known and more appreciated than it was fifteen years ago. His purpose was to construct a calculus of operators which should yield all the irreducible concomitants of a set of algebraic forms. He partly achieved this aim; but in pursuit of it he discovered an ancillary calculus, that of his famous "tableau" operators, by the aid of which he obtained his important matrix representations, the "natural" and the "semi-normal", of the symmetric group.

The papers of Young are still, however, not easy reading, partly because, here as in other cases, the order of discovery is not necessarily the best order for the exposition of the results. Dr. Rutherford, having devoted many years to the study of Young's memoirs, has composed a treatise of substitutional analysis. He has chosen his own order, and has aimed first at obtaining the semi-normal and orthogonal representations. It is well known how Young, having developed a theory of tableau operators in two papers of 1900 and 1902, resumed the work after an interval of twenty-five years by singling out a special set or basis, the famous "standard tableau" operators, the "Young symmetrizers", as they have been sometimes called. These yielded a "natural" (one might rather say "rational") representation of the irreducible sub-algebras of the group algebra of the symmetric group. None the less, the advantage of rationality was offset by the disadvantage of a loss of symmetry of procedure, perceptible already in the group of order 5!; the operators required modification by linear combination. For this and other reasons, Young proceeded to transform the natural representation into the semi-normal representation, which is at only one remove from the orthogonal representation.

Dr. Rutherford has chosen to lay emphasis, rightly in our opinion, on the semi-normal and the orthogonal representations, and on the work of the American algebraist, R. M. Thrall, in developing these *ab initio* without reference to the natural representation. The two earlier chapters are devoted to preliminaries, the calculus of permutations and the calculus of tableaux; the two later chapters contain applications to group characters and to the solution of substitutional equations. This last is original work by the author himself. But throughout the book the treatment is very far from being a transcription of Young's material or methods. It is individual both in choice of order and in the use made of matrix algebra.

The book is a worthy addition to the literature of these topics, a literature which includes the original memoirs of Frobenius and Schur on group representation, those of Schur himself on the homomorphisms of the linear group, the papers of Young, and the treatises of Weyl, Murnaghan and D. E. Littlewood.

It is a feature of interest that the book is the first mathematical treatise to be published by the recently founded Edinburgh University Press. The format and typography are excellent; we have failed to note any errors in the intricate printing.

A. C. AITKEN

BIRDS OF A GREAT METROPOLIS

London's Birds

By R. S. R. Fitter. Pp. 256+23 plates. (London: William Collins, Sons and Co., Ltd., 1949.) 10*s*. 6*d*. net.

HERE is a history, assembled from the voluminous but scattered literature and brought up to date, of the birds recorded in the County of London. A map is provided showing the County's limits; but the author frequently strays into Greater London in search of rarer species. The birds are grouped into chapters according to habitats: birds which nest on or frequent buildings, the ground, trees and shrubs, marshes and the Thames, and even the air itself has a chapter; followed by chapters on migration and predators, including man's influence for evil and good. This treatment has resulted in some overlapping and repetition, but otherwise the book is absorbing, and of great value as a guide for the many Londoners interested in birds.

It is a depressing history in its revelation of the number of rare, vanishing and lost species on London's bird-list. This decline has been going on for more than a hundred years, and is due primarily to the failure of food supply which has followed intensive building and the disappearance of open spaces. Direct persecution by man (shooting, bird-catching and egg-collecting) is only a subsidiary factor in this decline, as is the virtual disappearance from the streets of horse-droppings, on which finches and other birds formerly thrived.

On the other hand, there has been an increase of certain adaptable species which would have astonished

London's early Victorian ornithologists. Woodpigeons and certain species of wildfowl find a security in breeding in London which is sometimes denied them in the country; and the gadwall, for example, is believed to have colonized Surrey waters from pairs put down to breed in St. James's Park. The black redstart is now at least twelve pairs strong, having found in the heaps of rubble and open weed-grown spaces of the bombed areas of the City suitable feeding and nesting sites. (Even wheatears on migration have taken to visiting these mounds of stones with scattered weeds, which to some degree resemble their natural rocky haunts. Nature, indeed, abhors a vacuum. The War has shown how swiftly much-devastated towns have been colonized by plant and animal life.) Five species of gulls not only winter regularly in London, but also some are beginning to remain throughout the summer, and the black-headed gull is now breeding in Middlesex.

Finally, there has been a great increase in public interest in the protection of London's birds, which should help the rarer species to remain and perhaps some lost species to become re-established.

R. M. Lockley

HYLL'S "FIRST GARDEN BOOK"

First Garden Book

Being a faithful Reprint of a Most Briefe and Pleasaunt Treatyse, Teachynge Howe to Dress, Sowe and Set a Garden by Thomas Hyll, Londyner 1563. Collated and Edited by Violet and Hal Trovillion. (Trovillion Private Press, at the sign of the Silver Horse, Herrin, Illinois, U.S.A., 1946.) 3 dollars.

IN these days of paper shortage and restrictions, it has remained for the enterprising owner of a private press in the Middle West to perform a service that has long been overdue. The first printed gardening book written in English has for centuries only been obtainable for reference in the greater libraries like the British Museum, and by so much is this reprint the more welcome. The suggestion was made to the publisher by Miss Eleanour Sinclair Rohde, who contributes a short introduction.

As to the book itself, it naturally owes a great deal to classic sources and constantly refers to them; but it contrives in a brief space to give careful instructions for choosing the site of a garden, and how to enclose it. The classic classification of soils is relied upon to instruct the novitiate gardener in selecting his garden ground and in teaching him which plants of the surprisingly wide selection available would be likely to thrive in which soils. The wise man will choose "a fatte and lose ground, which nedeth but small labour; and yieldeth plentifullest and greatest fruite".

After dealing with the construction of two designs of garden mazes, then an essential recreational part of any really splendid garden, Hyll proceeds to set out the times and seasons of planting each kind of seed he includes and the sort of soil that is suitable for them. The index comprises fifty-two herbs, many of them still familiar to our gardens and tables, but some that have long since passed out of use. The latter are mainly things that could only have been used as seasoning for flesh dishes and could not possibly have been used as vegetables in the modern sense of the term. Among such things are annis, basil, cherril, cummin, dill, fennel, mallow, orage, pennyroyal, poppy, rue, and other herbs that are still used in this way, like garlic, capers, parsley, sage, thyme and mint.

Among the vegetables that have continued in use are the artichoke, bean, beet, carrot, colewort, leek, onion, parsnip and spinage, and the salads include cresses, cucumbers, endive, lettuce, radish. Flowers were also grown for use as relishes, or for making into conserves, the carnation, gelyflower, hyssop, lily, rose and violet all being popular for this purpose.

But when all is said, this list is not very comprehensive, and, of course, that modern standby, the potato, is missing. The editors have chosen to omit "the medical details in regard to the uses of the herbs", and this omission is somewhat to be regretted, as all omissions from textual reprints are. Nevertheless, the task was well worth doing and has been done in a worthy manner.

G. E. Fussell

NUCLEAR FORCES

Nuclear Forces, Vol. 2

By Prof. L. Rosenfeld. (Monographs on Theoretical and Applied Physics, Vol. 1.) Pp. 183–544. (Amsterdam: North Holland Publishing Co., 1948.) n.p.

THERE are two main reasons why those who found the first volume of Prof. Rosenfeld's "Nuclear Forces" useful will welcome the appearance of the second. The first is naturally the subject-matter, which until now has been available only in the form of original papers and is here coherently collected for the first time. Secondly, the index and bibliography, referring to both volumes, and the absence of which from Volume 1 robbed it of much of its value, is at last available at the end of the present volume. Another attraction to all research workers in the field of nuclear physics is an up-to-date table of atomic nuclei, listing their chief physical characteristics, which is in many ways an improvement on the similar tables of Seaborg and of Flügge and Mattauch.

Volume 1 dealt with general features of nuclear forces, and a detailed study of the nuclear two-body problem. The present volume continues the analysis for more complex nuclei and includes the theory of the nuclear three- and four-body problems, the models used to describe heavy nuclei, the saturation characteristics of nuclear forces, the classification of nuclear energy-levels by means of group theory, and, above all, the results of the meson theories of nuclear forces. These topics are all treated with great thoroughness, and in a manner which will be useful primarily to the specialist, though the student wishing to learn the subject will also find much of interest to him.

There are, in addition, a number of useful appendixes dealing with beta-ray selection rules, the magnetic dipole and electric quadrupole moments of nuclei, and with the strong-coupling version of meson theories; they will be welcome, for it is difficult to find a simple treatment of these subjects elsewhere.

The present volume has the same virtues and suffers from the same defects as the earlier volume, and will appeal to the same class of reader. Taken together as a complete work, the two volumes constitute a scholarly achievement, in which chaos has been reduced to order, and will doubtless remain a standard work on the subject for many years to come.

M. H. L. Pryce

The *Terra Sigillata* (Samian Ware) of Margidunum

By Dr. Felix Oswald. Pp. 124 (56 plates). (Nottingham: The University, 1948.) 15*s*.

THE Roman site at Margidunum (Castle Hill, near East Bridgford, Nottinghamshire) had a long history, beginning with its foundation in A.D. 48 as one of the earliest forts of the Claudian conquest, and continuing in occupation, first as a military site and later as a posting station, until the end of the fourth century. It covers an area of seven acres, and that part of it excavated by Dr. Felix Oswald has produced many interesting discoveries, including a valuable collection of pottery of all periods.

The Terra Sigillata, which is the subject of this new report, includes examples dating from the first to the fourth centuries. It is arranged in nine chronological periods, and it is useful to be able to follow the development of certain long-lived types through the years by means of the descriptive material and the accompanying illustrations, in a book of such small and convenient size. Thus we find a common type like the plate, Form 18, appearing in the first period (Claudian), becoming deeper and larger, and finally developing into the deep plate or bowl of Form 31 by period 7 (Antonine). In period 8 (third century) this increases in size, and in the last period it is found among the fourth-century imitation Sigillata in grey ware with a scarlet wash, decorated with an interior central circular zone of rouletting.

Among the decorated ware the hemispherical bowl, Form 37, as usual, predominates. Some very early examples make their appearance in period 3 (Nero–Vespasian and Vespasian), and include bowls by the potter Mommo with designs which are the same as those on the signed bowls of this potter identified at Pompeii. In period 5 (Trajan) there is the usual appearance of new styles of ornamentation, and among the fourth-century imitation Sigillata is a bowl of this shape with stamped decoration consisting of rows of oblong geometric motifs. A few fragments of Arretine ware found in the Claudian layers are survivals of the late Augustan age, and another interesting early find was a bowl of Form 24 with the red and yellow marbled glaze rarely found in Britain, Margidunum being the most northerly site where it occurs. Among other discoveries may be mentioned the inkpots, one of period 3, which Dr. Oswald suggests was probably for official use, and the other of period 4 (Hadrian–Antonine), with a cursive inscription by Casurius.

JOAN LIVERSIDGE

College Geography

By Prof. Daniel R. Bergsmark. Third edition, revised by Earl C. Case. Pp. x + 790. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 5 dollars.

THE scope of geography as taught in American schools has generally a strong regional outlook, with the United States underlined. This volume is a little unusual in that it bases the regional account of the world on climatic regions with relatively little attention to other physical factors except relief. Areas important chiefly for mineral wealth have to come outside this classification and be treated separately. The book is a third edition of "College Geography" published in 1932 and has been brought well up to date—a difficult task in these days of change and uncertainty. A new chapter has been added on Pacific islands where America has found increased interests. There are abundant diagrams and illustrations and copious references to relevant publications, one of the best features of the book. Its accuracy, fullness and lack of bias make this a most useful book of its kind, but, of course, too expensive for schools in Great Britain.

Arctic Unfolding

Experiences and Observations during a Canadian Airborne Expedition in Northern Ungava, the Northwest Territories, and the Arctic Archipelago. By Prof. Nicholas Polunin. Pp. 348+33 plates. (London: Hutchinson and Co. (Publishers), Ltd., 1949.) 21*s*. net.

PROF. POLUNIN had already considerable experience of various parts of the Arctic when he got the chance to visit by air several parts of the Canadian Eastern Arctic. The expedition spent some days at various places, including Southampton Island, Chimo and Port Harrison in the Ungava Peninsula. The flights were mainly concerned with survey and resulted in changes in the map around Foxe Basin and the location of the elusive Spicer Islands. The author's main interests are botanical, and so there are detailed notes on the vegetation besides many floristic records. Birds, too, come in for notice. It was not a long expedition in time, although a wide extent of islands and seas was covered. Prof. Polunin has followed closely his diary, a method that results in vivid descriptions of scenery and incident, but tends to emphasize the monotony of the region and the repetition of detail. The book, however, is a useful addition to works on the Canadian Arctic. There are many but not outstanding photographs. One of several appendixes gives instructions as to what and how to collect. There is a useful bibliography.

Non-Ferrous Castings

By R. F. Hudson. Pp. x+282+xxiii. (London: Chapman and Hall, Ltd., 1948.) 22*s*. net.

THE objects of this volume are set out with clearness and modesty in the author's preface. The main purpose of the book is to present "the scientific viewpoint to the practical man in a language he understands". Any endeavour to promote better understanding, and a consequent higher degree of co-operation, between the practical man and the metallurgist is to be admired, and as such the book is to be welcomed.

Naturally, a book of this size cannot cover exhaustively the whole subject of non-ferrous metal casting, and the author has restricted himself to the brass and bronze founding industry, of which he has, obviously, a first-hand knowledge and much practical experience. The first three chapters are devoted to a description of the incoming foundry materials, such as metals, fuels, refractories and sands. Much useful information is given; but efforts at simplification have led, in certain instances, to misleading statements. A eutectic, for example, is defined as "that part of the compound which solidifies last". Photomicrographs included in the first three plates lose value in that no magnification is stated. The second portion of the book deals with moulding, melting and gating practice for most of the standard copper- and nickel-base alloys and some special alloys. In these chapters much valuable information, drawn from practical experience and the results of research by national associations, is presented in logical sequence. The remaining chapters are devoted

to the casting of test-bars; the salvaging and repair of defective castings; chill and centrifugal casting. They include sound practical advice and useful lists of references. A feature of the book is the two appendixes, which include a series of excellent photographs of common defects in castings and photomicrographs of the more common non-ferrous alloys. The volume should form a useful addition to the library of both foundryman and metallurgist.

F. ORME

The Freedom of Necessity

By J. D. Bernal. Pp. xi+437. (London: Routledge and Kegan Paul, Ltd., 1949.) 18*s*. net.

IN this volume, Prof. Bernal has collected a number of essays published at different times during the last twenty years in a wide range of periodicals. They deal with many different topics, including the organisation of science, the relations between science and the humanities, the arts, and philosophy, science in economics and politics, the atomic age and Marxism. Prof. Bernal claims for them little unity beyond that of authorship, except an attempt to grasp the different aspects of the forces which are moulding our time, to weld them together and to interpret them in a way which will lead to some control over these forces. That attempt is most marked in the longest essay bearing the title of the book, but even here the interpretation is partial and unduly influenced by Marxist preconceptions. Some of the assertions make strange reading in view of what is happening in the U.S.S.R. and the countries under Soviet control to-day. Prof. Bernal is happiest in such essays as those on "Research in War and Peace", on "Lessons of the War for Science", on "International Scientific Organisation" or "The Function of the Scientist in Government Policy and Administration", and there could not well be anything more forthright than his reiteration in the two essays, "Science and Liberty" and "Liberty and the Individual: the Scientist's View", that the fate of science depends upon the preservation of liberty. Nevertheless, Prof. Bernal shows strange reservations, if indeed not aberrations, in the interpretation of liberty; and while he scarcely makes plain exactly what he means by the freedom of necessity, he will leave some of his readers unconvinced that he himself really believes in the necessity of freedom, save for those who accept the theories and practice of Marx, Lenin and Stalin, upon which, in his view, depend the collaboration required to integrate old beliefs and new conditions, and the assurance of peace and democracy.

R. B.

The Clove Tree

By G. E. Tidbury. Pp. xii+212+24 plates. (London: Crosby Lockwood and Son, Ltd., 1949.) 18*s*. net.

IN view of the interest taken in cloves and the severe damage that has been caused to the plantations in Zanzibar and Pemba in recent years through disease ('sudden death' disease), it is fitting that a book devoted entirely to the crop should now appear. The author, an agricultural officer of the Zanzibar Protectorate, has had a wide experience of the crop. His book commences with an interesting account of the early history of the clove trade. All aspects of the cultivation and production of cloves, as practised in Zanzibar and Pemba, are then dealt with.

The chapter devoted to "Diseases and Pests of the Clove" is quite naturally concerned largely with 'sudden death' disease. Although little appears to be known as to the real cause of this mysterious disease, it is of interest to note that it is considered to have been present in Zanzibar since the middle of the last century. Work on the disease, intensified in the last few years, has involved attempts to graft the clove on other species of *Eugenia*, so far with not overmuch success. The genus *Eugenia* is a large one (more than six hundred species), but only certain of the species may be regarded as closely related to the clove. It is here that the advice and help of the systematic or taxonomic botanist familiar with this large genus is likely to prove of real value. A detailed revision of the species of *Eugenia* of Malaya, which has also just appeared ("The Genus *Eugenia* (Myrtaceae) in Malaya", by M. R. Henderson, *Gardens Bull. Singapore*, **12** (1), 293; 1949), may therefore quite conceivably have an important bearing eventually on the apparently unrelated subject of world clove supplies.

The Statesman's Year-Book

Statistical and Historical Annual of the States of the World for the Year 1949. Edited by Dr. S. H. Steinberg. Eighty-sixth annual publication: Revised after Official Returns. Pp. xxiv+1544. (London: Macmillan and Co., Ltd., 1949.) 36*s*. net.

A NEW edition of this book of reference, revised up to the spring of this year, is most welcome. Broadly speaking, it follows the familiar order of British Commonwealth and Empire, United States and foreign countries, and the proportionate allotment of space is retained; but political events in a restless world have necessitated many changes and several temporary allocations, such as the overlapping claims of Britain, Chile and Argentina to sovereignty in the Antarctic or the divided allegiance of Korea. Statistics from some parts of the world are difficult to get, but the editor has rarely been beaten. A recent addition is an indication of the flag and national anthem of each State. Lists of books have been revised. There are chapters on the United Nations, the North Atlantic Treaty, the Arab League, the World Council of Churches and other international organisations, as well as statistics of world production of cereals, sugar and cotton. Two coloured maps illustrate respectively Indonesia and the West Indies.

Birds of Britain

A Guide to the Common Species. By J. D. Macdonald. Pp. 153 + 9 plates. (London: George Bell and Sons, Ltd., 1949.) 8*s*. 6*d*. net.

THE purpose of this book is to provide the beginner with a means of identifying the more common birds of the British Isles, for which purpose they are arranged in groups such as seed-eaters, waterfowl, and so on. The grouping of hawks and hawk-like birds together brings the cuckoo next to the red-backed shrike and the hen harrier, to be followed by the owls and nightjar. The line drawings in the text are excellent, being both helpful and life-like. The coloured plates are not so successful, probably owing to difficulty in reproduction. For example, the portrait of a nuthatch gives the bird a back the colour of a blue sky on a summer day. However, the book should serve its purpose well and enable the novice to name the birds he sees in field and wood, on hill and shore. The little volume concludes with a list of bird weights, information rarely given in ornithological literature, ranging from the golden eagle, 9–10 lb., to the goldcrest, $\frac{1}{4}$ oz.

FRANCES PITT

WORLD FOOD AND WORLD POPULATION

DURING the recent meeting at Newcastle upon Tyne of the British Association a public meeting was held on "World Food and World Population" under the chairmanship of the president, Sir John Russell. The other speakers were Prof. Pierre Auger (Unesco), Lord Horder, Lord Bledisloe, Sir David Rivett (Australia), and Dr. P. O. Ripley (Canada).

Sir John Russell, introducing the speakers, said that the only way to increase food production so as to keep pace with the rising tide of population is to increase the productivity of the limited, though as yet not wholly used, area of land available for agriculture. Prof. Auger drew a contrast between the eagerness with which Great Britain (and other countries) accepted the innovation of the railway as a means of increasing the wealth and resources of mankind with the prevalent doubt as to whether science should be regarded as a friend or the enemy of mankind. If man wishes, he said, he can use science and technology to free himself—to rid himself of illness and disease, and to remove the burden of unproductive and uneconomic toil. The United Nations Educational, Scientific and Cultural Organisation has begun a major experiment in mass enlightenment, organising in many countries active discussion of the topic of the meeting—food and the people—with the object of focusing the attention of the peoples of the world on this urgent problem. It hopes to show not only the necessity for international collaboration in solving the problem, but also that such collaboration is already taking place at all levels among the existing international organisations.

Lord Horder also believed that if we wished, we could achieve such physical, chemical and biological control of the earth as to enable us to adjust population to food as well as food to population. But merely wishing for it is not enough. Food will not be produced, even with the full utilization of science, without hard work, and the ultimate consideration is moral control, of which the simplest expression is 'live and let live'. Does it come within the province of science to obtain that indispensable moral control?

The subsequent speakers described the contributions that are being made by, and some of the difficulties that are being encountered in, Great Britain, Australia and Canada in supplying the world with its rapidly growing food requirements.

Lord Bledisloe pointed out that Britain is one of the most densely populated and most highly industrialized countries, and he thought that so long as her present population is maintained she will remain the greatest food-importing area in the world. Nevertheless, she is making a major contribution to world food supplies. Home-produced food has been increased by 30 per cent since before the War, and, if the plans envisaged in the Agriculture Act of 1947 are carried out, production would soon be raised to 50 per cent above pre-war level. If the incentive were provided, production could possibly be raised by a further 20 per cent.

Sir David Rivett said that Australians cannot be complacent about the contribution they are making towards feeding the world. The difficulties in the way of a rapid expansion of agriculture in Australia are immense, and an acceleration of expansion requires far more powerful catalysts than have yet been applied. Public enemy No. 1 is lack of water, and even in the relatively well-watered regions the spectre of drought is never absent. The disappointments that are to be expected from unfavourable weather are exemplified by the recent announcement that the anticipated harvest this year of a million bushels of grain sorghum from the new Queensland project of the Overseas Food Corporation will be reduced to 320,000 bushels as a result of frost damage.

The first call is for large-scale water conservation, irrigation and hydro-electric schemes. Great developments have been planned, but it will be thirty years before they come to full fruition. Sir David emphasized that irrigation presents problems not only to the engineer, but also perhaps even more to the soil chemist, upon whom the whole success of an irrigation project often depends.

To illustrate the scale on which production for export may be expanded in Australia, Sir David pointed out that if the plans for increased beef production in North Australia are realized, they will result in an additional 50,000 tons per annum of beef for Britain in fifteen years time—but this is only equivalent to 2¼ lb. per person.

In some important directions much more scientific investigation is necessary before development plans for increased production can be launched. These investigations require first-class research workers, and one of the most profitable and mutually beneficial exports that Britain could make to Australia is first-class men of science. Geneticists are needed to develop from British cattle breeds that are already established in Australia strains adapted to local conditions—perhaps by the introduction of selected characteristics from zebu and other types. The merino sheep also presents many challenges to breeders. The fertility of rams is affected by high temperatures and certain deficiencies, and knowledge of climatic influences on the fertility of both rams and ewes is needed to raise the present low lambing percentage.

Dairying presents the biggest opening for the application of science to both breeding and feeding. At present the annual butter-fat yield per cow in Australia is only half that in Great Britain. The introduction of new pasture species, the establishment of legumes and the growth of fodder crops are all essential to increasing the productivity of the livestock industry.

Dr. Ripley likewise warned the audience about the popular conceptions of Canada as a source of unlimited food production. He said that improved agricultural land in Canada amounts to only about 90 million acres out of a total of 140 million now used for production of field crops. With a higher technical level of production and a forced economy, the agricultural area might be increased by another 100 million acres. He pointed out that in 1939 the food exports of Canada amounted to only 10 per cent of her total exports. Great strides have, of course, been made in agricultural production in the last seventy-five years, and still more can be done, though expansion in the future is going to be much more difficult than in the past.

Wheat, being the chief food commodity produced, is receiving special attention. It is estimated that

the search for, and the growing of, rust-resistant varieties have increased annual wheat production by forty million bushels. Better rust-resistant strains than the present ones are, however, being sought.

More efficient utilization of moisture on twenty million acres of arid prairie land is being obtained by developing wheats with low moisture requirements, and by encouraging practices of strip cropping, trash farming and the ploughless fallow. As in Australia, large sums of money have been allocated to the extension of the irrigated area, especially in Alberta. Special attention is being given to the possibilities of extending the present limit of agricultural production northwards, and experimental farms have been established beyond the Arctic Circle. Soil surveys are enabling newly opened land to be used in an efficient manner, and continuous progress is being made in methods of soil conservation and crop nutrition. Weed eradication with hormone weed-killers was carried out on four million acres in 1948. Grassland improvement is being intensively studied, and in some regions the carrying capacity of pastures has been increased three- or four-fold. Together with this, livestock improvement has received considerable attention.

None of the speakers at this meeting knew beforehand how the others would treat the subject, consequently there was considerable diversity in approach. There was, however, general agreement that the present resources of the world, if properly exploited, are more than adequate to feed the present population. The danger is that progress in expanding food production and distributing the products of agriculture may prove to be too slow to avoid widespread want.

LONDON'S WATER-SUPPLIES

By Prof. H. L. HAWKINS, F.R.S.

AMONG the many problems aggravated by human gregariousness, none is more pressing than that of the supply of water. Life, whether bodily, domestic or industrial, is impossible without a continuous and reliable source of water. Early settlers were, for the most part, influenced in their choice of sites by the ready availability of springs, rivers or dipping-wells. But if the settlement flourished the local supplies soon became inadequate in volume and dangerous in quality. Cities became plague-stricken for reasons obvious enough to us, but mysterious and supernatural to their inhabitants.

The founders of London were more fortunate than they knew in their choice of location, and (to be wise after the event) their descendants were perhaps more fortunate than they deserved. The common suffix 'well' that follows so many names of streets and districts in London testifies to the abundance of springs that served the city and its environs. When, owing to the congestion of domestic and industrial sewage, these springs changed from sources of welfare to cesspools of disease, others remote from populous areas were of necessity exploited, and the water from them had to be transported by conduits or pipe-lines to the region of its consumption. One of the latest of those schemes still functions as the 'New River' in the valley of the Lee. To-day Chadwell Hole, which was the fountain-head of that aqueduct, is more of a swallet than a spring.

When the art of well-boring developed, the vast hidden reservoir over which London was extending was soon discovered. Very many of the early deep wells in the area gave an artesian overflow, for the geological structure of the London Basin, with its impervious seal of clay covering a downwarped mass of porous chalk about 700 ft. thick, is one that might be considered ideal in that respect. Not only is London near the open end of a pitching syncline, but also a series of cross-folds located there bring the Chalk within fairly easy reach, and so shatter its fabric that its porosity is vastly increased.

So saturated was this huge body of Chalk that innumerable springs, some permanent and some 'winterbournes', broke surface along the margin of the clay covering. Practically all those springs are to-day in no better case than Chadwell, nor does any well in the area provide an artesian overflow. Over a large part of the district the level of saturation is well below the base of the covering clay, so that the upper portions of the Chalk are virtually dry.

Where natural overflow was insufficient or lacking, it became necessary to pump from the wells, so that, in addition to the drain on current account, the capital reserve was tapped. With no sort of effective control, well after well was sunk, and a tragic game of 'beggar-my-neighbour' ensued. There are now four thousand or more pumping-wells in the Greater London area, sucking out the water from the Chalk at the rate of about 260 million gallons per day. Natural replenishment cannot keep pace with such voluminous and persistent withdrawal. It is not surprising that the marginal overflow springs have failed, and that many of the less deep wells are out of action.

To-day, as in the past, the tendency is to exploit the water resources of the periphery, since the central region has begun to fail. New factories and extended public supplies thus catch the water that was on its way to replace the depleted central supplies, and their heavy pumping tends to produce new areas of depression in the chalk water-level. Even in the far west of the London Basin, the level of saturation is falling; and, although natural causes may be at work in this, the relentless suction of thousands of pumps lower down the syncline must be at least partly responsible.

With the discovery of chemical means of purifying water, the rivers are now tapped to make up the balance of the 568 million gallons required every day in the Greater London area. The Thames, Lee and Stour provide London with about 300 million gallons daily; and, except in seasons of extreme drought, exceed in their contributions the output of the wells. But much of the permanent flow of the rivers is maintained by springs, and these are dwindling with the general lowering of the water-level in the Chalk. Sufficient water must be allowed to flow over Teddington weir to flush the sewage from the estuary; and the Lee is fast becoming so polluted that its purification is approaching the economic limit.

The problem of maintaining and co-ordinating the supply of water to the ever-growing metropolis has been the subject of many inquiries. From the point of view of determination of the resources available, the problem is difficult enough; but in the matter of administration it is profoundly complicated. The expansion of London has involved the incorporation of townships and villages that had already developed their own schemes of water-supply; and many of these corporations and companies continue to function independently. In the early part of this

century some measure of centralization was achieved by the creation of the Metropolitan Water Board; but still nearly all suburban districts are served by their own special undertakings.

The latest inquiry was held before a departmental committee of the Ministry of Health in 1947, and the committee's report was issued a year later. That report endorsed the contention of the Metropolitan Water Board that a central authority should be established for controlling and allocating the water-supplies of London. In the area suggested by the Board (but not wholly accepted by the committee), there are at present no fewer than sixty-five public water-undertakings responsible for providing supplies to areas of very varying extent.

The Metropolitan Water Board has just issued a "Review of the Resources and Consumption of Water in the Greater London Area"* compiled by Prof. P. G. H. Boswell from the technical evidence submitted at the inquiry. The greater part of the evidence is that supplied by Prof. Boswell himself; only those with experience of that sort of work can appreciate fully the immensity of the labour involved in establishing the facts and the difficulty of submitting the results in a concise and intelligible form. This lavishly illustrated review is both concise and readable, and it will be an outstanding example in the succession of reviews that is inevitable in the case of a problem that can never be static. The only material omission seems to be the date of publication; but that can be inferred from internal evidence.

In twenty-one folio pages, packed with statistics but never unreadable, the complete balance sheet of supply and demand, actual and potential, is set forth; and the verbal account is illustrated by ten large coloured maps and three full-page diagrams.

Although the factual data are beyond dispute, the calculations concerning future resources and needs are naturally less precise. One element of uncertainty is inevitable, for it is impossible to foresee the future history of the London area. But the uncertainty as to resources could be lessened if our knowledge of the behaviour of water, above ground and below, were enlarged. The flow of but few of the rivers in and about the area has been gauged; such measurements must be carried out over long periods if they are to become significant; they should be instituted forthwith. Again, our knowledge of the direction, rate and other aspects of the percolation of water through the Chalk is very imperfect, and it can be improved only by long-term research.

The last few pages of Prof. Boswell's review are devoted to suggestions for researches, many of which could scarcely have been envisaged by a water-engineer who was not also a 'pure' geologist. It is a lamentable fact that in spite of more than four thousand borings reaching to the Chalk in the Greater London area, the zone of the Chalk next below the Tertiaries is known in scarcely a score of cases. Without that knowledge the structural features in the body of the Chalk cannot be determined, and those are the determinants of costiveness and permeability. Palæontology, and in particular micro-palæontology, may well prove to be as important for locating water as it is in the case of oil.

It would be unlikely that small, and often competitive, undertakings could finance researches which must be prolonged before any practical results accrue. But when the central authority is established, it may be expected that enough financial patience will be available to instigate such research; as well as, if need be, to embark on the large-scale work involved in bringing water to London from distant sources.

The need for more reliable supplies is urgent, if not desperate. Perhaps, had there been central control during the past fifty years, the problem would not now be so acute; it is a matter for hope and expectancy that its establishment will lighten the burden of anxiety before this century has come to an end.

* Metropolitan Water Board. A Review of the Resources and Consumption of Water in the Greater London Area. By Prof. P. G. H. Boswell. Pp. 23+10 pl. (London: P. S. King and Staples, Ltd.) 10s. 6d.

THE IMPACT OF SCIENCE ON SOCIETY

DURING the fourth annual conference of the Rationalist Press Association, held at Magdalen College, Oxford, during August 5–9, the main theme for discussion was "Science and Society". In his presidential address, which opened the proceedings, Prof. A. E. Heath (University College, Swansea) dealt with scientific method, as applied to the social field. Referring to the opinion held in some quarters that as soon as we enter the domain of social and political affairs something other than normal scientific procedure is called for, he asserted that science is only common-sense reflexion more critically and more consistently applied, and that any field of human experience can become a science. What makes a study scientific is not the nature of the things it deals with but the way it deals with them. The first step in scientific method is the critical observation of any given body of facts, and the second is the setting out of these facts in some sort of scientific order; then that order is tested and we are led to new facts which in turn have to be ordered, and so on in an endless series. In saying that reflexion upon facts becomes scientific by becoming more critical and systematic, we must not suppose that the change was an easy one; it involved centuries of human struggle. Resistance to scientific treatment was particularly strong in human and social studies because we lack the courage to be critical in matters which come too closely home to our frail human nature. This perpetual struggle to put statements about our experience in testable form is not, however, the end of the story. In the less mature sciences there may still be alternative modes of ordering the facts. Social studies are still at the stage when there are many divergent possible modes of dealing with the same body of facts concerning human behaviour. To pass from J. B. Watson to Freud, or from Jung to Adler, is like moving into different worlds; yet all these psychologists dealt with the same human facts, however different the terms they employed to interpret them and throw them into fruitful combinations. Our trouble in applying scientific method to the social sciences would be overcome if we could realize that novelty is a directly observable fact in the development of men and society. The theory of evolution is a critical step in our methods of thinking because it involves a recognition of novelty in science: if we are to master and direct our world, we must learn how to cope not only with the orderly but also with the novel aspects of the universe, even when that novelty is of our own making. Scientific method can be applied by taking into account the

pliancy of life, thus achieving some measure of control out of the very heart of the unexpected and incalculable.

On the evening of Sunday, August 6, Lord Boyd Orr delivered a public lecture on "Science and Peace". He had chosen this title because he traced the major cause of the great disorder of the world to science, and held that there is no hope of peace until mankind frees itself from superstitions and inherited beliefs, looks at the facts as they are, and seeks to adjust the structure of society so that the great powers that science has given us might be directed towards beneficial instead of destructive ends. Changes in the structure of society are nothing new; ever since the dawn of history they have arisen from new knowledge and inventions, and even more importantly from the generation of new ideas. When the fabric of society is so very rigid that it cannot adapt itself to new knowledge, the result is a breakdown of the fabric, with social unrest, revolution and war. The world to-day is changing more rapidly than ever before under the influence of the tremendous advances in technology, which enable us to produce goods in unprecedented abundance; the spread of the idea of the potential equality of all races and all classes, leading to a revolt against domination by church or State or by any Powers; these have been accompanied by a revolution in transport and communications which has brought the nations so closely together that they must either agree to live in peace or have a third world war. Thus the advance of science in the last fifty years has brought mankind into a new age for which it is ill prepared, either intellectually or morally. This new age with modern science might be a great age, freeing man from physical poverty and his mind from ignorance and false beliefs, and raising mankind to a very much higher level of physical, cultural and intellectual well-being. The difficulty of entering the new age lies in the resistance of those who do not want change; to overcome this obstacle we must look to the rarest people in the world—those with intellectual courage, completely disinterested, completely objective, making their observations, getting their facts and using their intellect to make deductions from the facts, and discarding all superstitions, myths and false beliefs. By adopting a positive policy, telling the masses what science can do, and creating a new faith in mankind itself, they could provide the great driving force to carry us through these difficult times and to realize the kind of world we hope to hand on to our children and grandchildren. The people of the world are thirsting for truth, thirsting to be released from the chains of superstition, thirsting to be released from poverty.

For his lecture on August 7, Dr. Meyer Fortes took the subject of "The Conflict of Science and Belief: and Anthropological Comment". Observing that European civilization is marked out from all others by the possession of the natural sciences, he pointed out that the majority of mankind has always managed, and still manages, to achieve what is to each group a very satisfying way of life without science. There is plenty of evidence that science is not indispensable for creating an elaborate and rich civilization. Therefore, the crux of the problem of science and society is not the usefulness of science but the value we attached to science in our modern civilization. Society is as much a higher product of evolution as other physiological characteristics of mankind, and it exists only by virtue of collective possessions, some of which are material and may survive, and others are non-material—such as knowledge, skill and tradition—which exist only in the mutual intercourse of man. The consideration of science as part of our social outfit raises the question of by whom and in what way is science owned and used in our society. Science is not a cultural possession of the same kind as our knowledge of reading and writing; through its technical appliances it can be possessed by innumerable people who understand nothing about how they work. Science in itself is really the peculiar possession of a small élite called 'scientists', who have a body of knowledge and skill anxiously collected by long and special application. Technology is not science, and the nearest thing in a pre-scientific civilization was not the maker of tools but the priest, the magician, who possessed esoteric knowledge. Apart from technology, science is a source of ideas and discoveries enabling us to interpret what is happening outside us and inside us.

Social aspects of medicine were discussed by Dr. Alice M. Stewart (Institute of Social Medicine, Oxford) and by Surgeon Vice-Admiral Sir Sheldon Dudley (late medical director-general of the Royal Navy). Dr. Stewart traced the evolution of social medicine from the realization that medical men, in addition to healing the sick, might play a part in the prevention of disease up to the stage reached by a few departments of social medicine which study the social, genetic, environmental, occupational and domestic factors bearing on human disease and disability. The methods of research in this field were illustrated by a detailed account of the investigation carried out by the Oxford Institute on the incidence of tuberculosis in a section of the shoe industry. Dr. Stewart maintained that the first thing to be done in the case of diseases such as cancer, the causes of which are unknown, is to make a thorough examination, by statistical and other means, of the environmental factors.

Under the title of "Social Health—a Neglected Chapter of Sociology", Sir Sheldon Dudley supplemented a plea for more extensive training in the human sciences by claiming that, as an instrument of general culture, sociology must include the most important of all these sciences, namely, hygiene, or social health, meaning the principles by which the health of society is preserved. A real national health service would be staffed by physiologists and non-medical psychologists—the scientists of normality—on an equal footing with physicians, psychiatrists, and pathologists—the masters of abnormality. These, again, should work with the architects, the engineers, food producers, educationists and schoolmasters responsible for the physical and cultural environments. The most important division of social health is the scientific development of the child's potential abilities and personality; the fundamental influence of a healthy national training in infancy and early childhood on the subsequent health and sanity of adult societies has generally been overlooked. A scientific education, as distinct from education in science, must be based first on psychology, the study of human nature; secondly, on logic, which is formalized common sense; thirdly, on statistics, the basis of all sense of proportion; and fourthly, on semantics, the science of knowing what you mean.

Sir Sheldon Dudley's address was followed by an autobiographical account by Lord Raglan, under the heading of "Religion and Life", of the development of his views on fundamental problems. The con-

cluding address was on "The Control of Population", by Dr. C. P. Blacker (secretary of the Eugenics Society). He dealt mainly with the manner in which the need to control population affects Great Britain and the Commonwealth, and how it will shortly present itself to the world. As regards Great Britain, he suggested that, in our present precarious economic conditions, our basic position would be safer if our population were reduced to within five or six per cent of the number we could feed from our own resources. In the case of the Commonwealth, he hoped that a Commonwealth Institute of Demographic Studies, concerned with collecting information, could be formed, and that its work could be supplemented by a Commonwealth Office of Population, designed to weld the Commonwealth into a demographic unity. In connexion with the world problem, he maintained that there is but one solution for countries like India and China, now struggling in the high stationary and early expanding phase of the demographic cycle—the deliberate control of fertility. Admitting that the task of transforming unbending forms of thought and custom, evolved over millennia and interwoven in the texture of religion, is formidable, there are signs that a sense of demographic realities is spreading among enlightened men in India and elsewhere. Under the impact of Government encouragement and feminist propaganda, and in the presence of specially provided facilities, what has been called the 'cake of custom' might break up more easily than seemed possible.

ELECTRONIC CALCULATING-MACHINE DEVELOPMENT IN CAMBRIDGE

By Dr. M. V. WILKES

In a recent article (see *Nature*, August 27, p. 341) an account was given of a conference on high-speed digital calculating machines held in the University Mathematical Laboratory, Cambridge. The article included a brief description of the EDSAC (electronic delay storage automatic calculator)[1,2], the large electronic calculating machine which has been built in the Laboratory, and its relationship to the various similar machines now under construction in England and the United States. It is intended to give here some further information about the EDSAC.

A digital calculating machine performs the operations of addition, subtraction, multiplication and division, and can, therefore, be used for solving any problem which can be reduced to arithmetical form. In a number of fields of research, mathematical formulation of the problems presented is possible, but analytical treatment of the resulting equations is either not feasible or is otherwise inappropriate. The methods of numerical analysis are, however, often applicable, and it may be expected that progress in such fields will be greatly accelerated by the application of high-speed calculating machines.

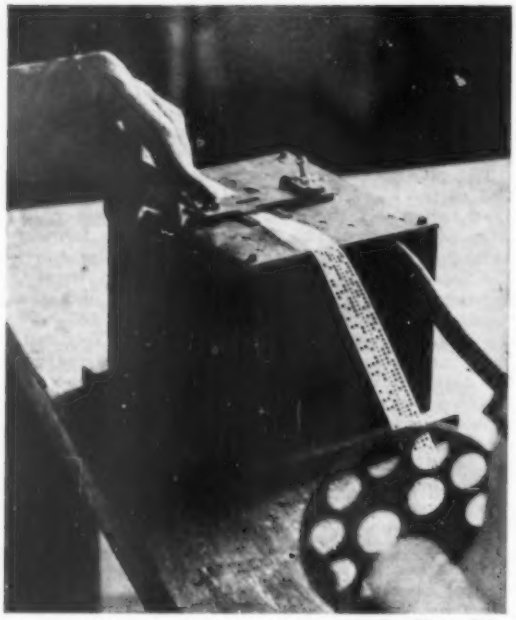
Much original work of a mathematical character may be necessary in order to reduce a problem to a form in which it can be put on the EDSAC. This will be specially true of problems which give rise to very large-scale computing operations such as become possible when a high-speed machine is available.

The photograph shown in Fig. 1 will give some idea of the size of the EDSAC. It contains about 3,000 valves and consumes 12 kilowatts of power. A problem is presented to the machine in the form of a punched paper tape of the kind used in telegraphy. The tape contains the programme, that is to say, instructions (in a coded form) for performing the successive arithmetical operations needed to solve the problem, and also any numerical data required. No other setting up of the machine besides putting the tape in the tape reader is necessary; the machine can, therefore, be switched rapidly from one problem to another. Fig. 2 is a photograph of the tape-reader with a tape in position. The results of the calculation are printed on a modified teleprinter. Instructions for the layout of the work and for printing any headings required must be included in the programme.

Except for the input and output mechanism, the EDSAC has no moving parts, all computing and control operations being performed by means of electronic circuits. Within the machine numbers are expressed in the scale of two and are represented by trains of pulses synchronized with a continuously running 'clock pulse' generator. If a pulse is present in a certain position in the train, the corresponding digit of the number is a 1; if there is no pulse, the digit is a 0.

Numbers expressed in this form are stored by a method depending on the use of an ultrasonic delay unit. The pulses are applied to a quartz crystal mounted at one end of a column of mercury, and give rise to ultrasonic pulses which travel through the mercury with the velocity of sound. On arrival at the far end they strike a second quartz crystal and are reconverted into electrical pulses. The time taken to traverse a column of mercury 5 ft. long is about 1 msec., and the interval between the beginning

Fig. 1. A general view of the EDSAC. The racks in the front row contain (from left to right): part of the store (two racks), pulse generator, and input-output units. Behind are three racks containing the control, and, in the rear, the remainder of the store (two racks) and the arithmetical unit (three racks). On the extreme right of the photograph may be seen the tape-reader for the input tape, and the teleprinter on which results are printed



Fox Photos, Ltd.

Fig. 2. The tape-reader, with an input tape in position, and part of the teleprinter

of one pulse and the beginning of the next is 2 μsec.; there can thus be as many as 500 pulses passing down the column at any one time. On emerging from the delay unit the pulses are amplified and reshaped, and passed back to the input of the delay unit. They then continue to circulate indefinitely and are available when required.

Conversion of numbers to and from the scale of two is effected automatically during input and output by the machine itself, acting under the control of instructions included in the programme. No inconvenience is therefore caused to mathematical users by the fact that the machine works in an unfamiliar scale.

An example of one type of problem which can be solved by means of the EDSAC is the evaluation of Airy's integral $Ai(-x)$ by the numerical solution of the differential equation $y'' + xy = 0$. There are many different methods based on the use of finite-difference formulæ by which this can be done; the one which will be taken as an example depends on the use of the well-known central difference formula

$$\delta^2 y = (\delta x)^2 (y'' + \tfrac{1}{12} \delta^2 y''),$$

where δx is the interval of the argument. If this is expressed in terms of three adjacent values of y, namely, y_0, y_1 and y_2, corresponding to the three equally spaced values of x, that is, x_0, x_1 and x_2, and use made of the differential equation to eliminate y'', it follows that

$$y_2 = 2y_1 - y_0 - \frac{1}{12} (\delta x)^2 (x_0 y_0 + 10 x_1 y_1 + x_2 y_2).$$

If y_0 and y_1 are known, y_2 may be obtained from this equation, and by repeated application a solution of the differential equation may be traced out point by point. Since y_2 occurs on the right-hand side with a small coefficient, the equation may conveniently be solved by an iterative method.

The problem may now be said to be expressed in arithmetical form. In order to set out in further detail the operations to be performed by the machine, it will be assumed that the quantities y_0 and y_1 are held in the store of the machine in 'storage locations' numbered 100 and 101 respectively, and that storage location 102 contains a number η. η will change as the calculation proceeds, and will finally become equal to y_2; initially $\eta = y_1$. The various stages of the calculation are then as follow: (1) Evaluate

$$\eta' = 2y_1 - y_0 - \frac{1}{12} (\delta x)^2 (x_0 y_0 + 10 x_1 y_1 + x_2 y_2).$$

(2) Examine the sign of $|\eta' - \eta| - \varepsilon$, where ε is a small quantity specified in advance. If the sign is positive, replace η in storage location 102 by η' and repeat (1). If the sign is negative, proceed to (3). (3) Print y_0. (4) Replace y_0 in storage location 100 by y_1 from storage location 101, and y_1 in storage location 101 by y_2 from storage location 102 (η remains in storage location 102). Repeat (1).

In this way the machine proceeds to evaluate the function step by step, performing as many iterations as may be necessary each time.

The various additions, subtractions and other operations which go to make up the stages of the calculation given above must now be listed in detail and expressed in terms of the order code of the machine[3]. Suitable orders must be added for starting the process from specified initial conditions and for stopping it when the solution has proceeded sufficiently far. The orders, together with all numerical parameters required, are now punched on a paper tape. The tape is placed in the tape reader, and the machine proceeds to evaluate and print successive values of $Ai(-x)$ without further intervention from the operator.

Fig. 3 is a photograph of a table of $Ai(-x)$ at intervals of 0·05 computed and printed by the EDSAC. The argument has been written in by hand; if desired, the machine could be made to print the argument by including appropriate orders in the programme.

About 150 orders were required to compute and print the table shown, and the time taken was four minutes. Of this, only about twenty seconds was occupied in computing, the rest being taken up by input and printing. In many problems of a more complicated kind, the computing time might be expected to be a larger fraction of the whole.

x	$A_i(-x)$				
0·00	+·35503	+·36796	+·38085	+·39364	+·40628
	+·41872	+·43090	+·44276	+·45423	+·46524
	+·47573	+·48552	+·49485	+·50353	+·51100
	+·51777	+·52357	+·52833	+·53196	+·53439
1·00	+·53556	+·53539	+·53381	+·53077	+·52619
	+·52005	+·51227	+·50283	+·49170	+·47885
	+·46426	+·44793	+·42986	+·41008	+·38861
	+·36548	+·34076	+·31451	+·28680	+·25773
2·00	+·22741	+·19595	+·16348	+·13016	+·09615
	+·06160	+·02671	−·00834	−·04333	−·07807
	−·11233	−·14588	−·17850	−·20997	−·24004
	−·26849	−·29510	−·31964	−·34191	−·36169
3·00	−·37881	−·39310	−·40438	−·41254	−·41744
	−·41901	−·41718	−·41191	−·40319	−·39105
	−·37553	−·35674	−·33478	−·30981	−·28201
	−·25151	−·21886	−·18402	−·14742	−·10938
4·00	−·07027	−·03065	+·00968	+·04970	+·08921
	+·12778	+·16500	+·20044	+·23370	+·26440
	+·29215	+·31562	+·33750	+·35449	+·36737
	+·37593	+·38004	+·37959	+·37454	+·36490

Fig. 3. An example of work done by the machine. The function $Ai(-x)$ is tabulated for values of x from 0 to 4·95 at intervals of 0·05. Five consecutive values are given in each line

[1] Wilkes, *Proc. Roy. Soc.*, A, **195**, 274 (1948).
[2] Wilkes and Renwick, *Elec. Eng.*, **20**, 208 (1948).
[3] Wilkes, *J. Sci. Instr.*, **26**, 217 (1949).

OBITUARIES

Sir Frederick W. Moore

By the death on August 23 of Sir Frederick Moore, Ireland has lost her premier horticulturist and Britain a very eminent student and grower of plants. He was born ninety-two years ago in the house in the Botanic Garden at Glasnevin. He studied in Dublin and Leyden, was engaged in practical gardening in Belgium, and succeeded to the keepership at Glasnevin on the death of his father, Dr. David Moore, also a noteworthy horticulturist and an energetic field botanist as well. At Glasnevin Sir Frederick lived and worked until his retirement after forty-three years service. The collections at Glasnevin, already notable, were added to greatly during his long term of office, and a high standard of culture was attained. Handicapped neither by the smoke of London nor the cold winds of Edinburgh, Glasnevin became an important centre of horticulture. Not that conditions were ideal there—"a droughty, draughty gravel-ridge" was the way Sir Frederick described the place to me more than fifty years ago; but his skill and knowledge succeeded in minimizing these disadvantages, and he showed a wise generosity in distributing difficult or half-hardy plants among the many Irish gardens more favourably situated, which rival in climate and soil those of Devon or Cornwall. He neither travelled much nor wrote much, and did no collecting in foreign lands, but devoted himself to the cultivation of the plants which he acquired from every part of the world. He was a horticulturist essentially, with an honoured name wherever rare or interesting plants are grown, and was ever ready to help with practical advice. Endowed with great physical and mental vigour almost to the end, he was a tower of strength in all matters relating to gardening and horticulture.

In Ireland Sir Frederick was a familiar figure in all the good gardens of that favoured country and at horticultural shows and occasions of a like nature. To the advancement of the Royal Horticultural Society of Ireland he did much, first as secretary for many years and then as president; when that Society instituted a gold medal of honour, he was one of the first recipients. From the Royal Horticultural Society he received the Victoria Medal of Honour and also the Veitch Memorial Medal in silver and in gold. In scientific life in Dublin he played an active part and served long on the council of the Royal Irish Academy, the Royal Zoological Society and other bodies; of the latter he was president for five years. He received the degree of M.A. from the Royal University of Ireland, Sc.D. from the University of Dublin, and in 1911 a knighthood.

R. Lloyd Praeger

Dr. F. E. Whitmore

By the death of Frank Edward Whitmore in a climbing accident on July 25, radiochemistry has lost a worker of much promise. He was twenty-six years of age.

Whitmore entered the University of Birmingham in 1945 from Handsworth Grammar School, where his talent for chemistry was already evident. He was a University scholar and later a prizeman, and duly took first-class honours in chemistry, remaining for three years after graduation to teach and to investigate single-crystal X-ray methods of determining the structure of organic crystals. This work, part of which was published in the *Journal of the Chemical Society*, gained him the degree of Ph.D. and an I.C.I. research fellowship, on the award of which he migrated to the Physics Department to take up the study of radiochemistry.

His particular interest was in the chemical state of atoms newly formed by nuclear transformation, and two communications on this subject were in the press when he died. He showed, for example, that phosphorus-32 made by the action of fast neutrons on the sulphur of sodium sulphide appears, when brought into aqueous solution, as an oxyphosphorus ion. He gave much time to the general chemical problems of a nuclear physics laboratory and will be remembered as a colleague who was generously helpful as well as very able.

In his hobbies of mountaineering and amateur dramatics, his ability and likeable personality brought him early responsibilities. He will be much missed by Midland climbers as well as by chemists and physicists. He was unmarried.

NEWS and VIEWS

Chief Scientist to the Ministry of Supply: Mr. H. M. Garner, C.B.

Mr. H. M. Garner has recently been appointed chief scientist to the Ministry of Supply, where he succeeds Sir Ben Lockspeiser. Mr. Garner has been engaged throughout the whole of his career on aeronautical research. He entered the Aerodynamics Department of the Royal Aircraft Establishment in 1917 and made notable contributions to theoretical investigations and full-scale experiments during the years 1917–29. He developed a strong interest in seaplanes and flying boats, and in 1929 was appointed chief technical officer of the Marine Aircraft Experimental Establishment, where he remained until the outbreak of war, when the Station was moved to Helensburgh. Mr. Garner was a great enthusiast for marine aircraft, and during the years when he was head of this Experimental Establishment he brought an expert knowledge, such as few people possessed, to the solution of many special problems and difficulties presented by flying-boats. Whether the large flying-boat—of more than 100 tons, say—will prove superior or not to the large land plane remains to be seen. But the present achievements of marine aircraft owe a great deal to Mr. Garner's enthusiasm and devotion to the subject. During the War, in 1942, his field of activity was widened by his appointment to the headquarters staff of the Ministry of Aircraft Production as deputy director of scientific research. He became, in 1946, principal director of scientific research in that Ministry, and later, on the re-organisation of Government departments, in the Ministry of Supply. He now succeeds to the post of chief scientist, to which he will bring a wide knowledge of science and research and much experience in administration.

Applied Physics at the New South Wales University of Technology: Mr. N. F. Astbury

ANOTHER chair of the newly founded New South Wales University of Technology (see *Nature*, August 13, p. 287) has been filled by the appointment of Mr. N. F. Astbury to be professor of applied physics. On leaving the University of Cambridge, Mr. Astbury joined the staff of the National Physical Laboratory and became responsible for much of the work on primary and secondary electrical standards, including the re-establishment of the primary inductance standard and a redetermination of the ohm with Hartshorn. During the War he worked on problems of harbour defence and electro-acoustics in the Royal Naval Scientific Service, and in 1945 joined Joseph Sankey and Sons to organise a research laboratory. This became the central laboratory of the Guest, Keen and Nettlefold group of companies, and Mr. Astbury is at present the director there. He has taken part in work on the processing and properties of electrical sheet-steel and has expanded the organisation to deal with a wide range of problems in applied physics.

Pacific Ocean Earthquake of August 21

A VIOLENT Pacific Ocean earthquake, late on August 21, near the coast of British Columbia, was the occasion for a very successful operation of the Hawaiian seismic sea-wave warning service developed by the U.S. Coast and Geodetic Survey. Upon the arrival of the earthquake waves, automatic alarms connected with seismographs sounded at the Survey's observatories at Honolulu, Hawaii; Tucson, Arizona; and Fairbanks, Alaska. The observers at all of these stations immediately attended their instruments, developed records and made readings. Tucson and Fairbanks promptly communicated theirs to the central station at Honolulu. Based upon these reports, the observer at Honolulu determined an almost exactly correct epicentre location and issued preliminary advisory warnings to military and public authorities at Honolulu in about one hour and a half after the time of the earthquake. This warning preceded the estimated arrival time of a seismic sea-wave, which might have resulted from this earthquake, by about four hours. Subsequent inquiries and messages to tide stations in Alaska showed that a small seismic sea-wave was produced; however, no such wave reached Hawaii in damaging proportions. The earthquake, though little publicized, was actually of greater magnitude than the disastrous recent earthquake of Ecuador, South America.

The development of this warning system grew out of the disastrous seismic sea-wave of April 1, 1946, when 173 persons died and damage amounting to 25,000,000 dollars was done in Hawaii. It has involved the development of visible-recording seismographs equipped with automatic earthquake alarms, and arrangement with a number of co-operating tide observers on Pacific islands or shores prepared to report seismic sea-wave information upon inquiry or in case such a wave is noted. Some of the tide stations are equipped also with a unique seismic sea-wave alarm device developed by the Survey. This is 'tuned' to respond to these characteristic waves of 10–25 min. period. Also involved was the development of high-priority communications facilities between the various points involved. The co-operation of the military services of the United States has been invaluable in the latter connexion.

Mathematical Colloquium in Manchester

A MATHEMATICAL colloquium was held in the University of Manchester during September 8–10. It was attended by more than a hundred members from most of the British universities and university colleges. The discussion sessions which occupied the greater part of the three days were devoted to analysis (two sessions), algebraic geometry, algebra, differential geometry and topology. They took the form of a short review of recent progress, followed by a general discussion. Lectures were given by Prof. H. R. Pitt (Belfast), on "Fourier Transforms", by Mr. P. Hall (Cambridge), on "The Basic Concepts of Abstract Algebra", and by Prof. J. H. C. Whitehead (Oxford), on "Homotopy Theory". The fact that most of the members were staying together in Dalton Hall, one of the halls of residence of the University, gave plenty of opportunity for those informal discussions which are so important a part of such meetings. It was the view of all those who took part that such a gathering should be a regular event, and a second colloquium will be held in 1950, probably in Oxford. To avoid clashing with the International Congress in September, this meeting will be held in the Easter vacation. The following were appointed a committee for the 1950 meeting: Prof. H. A. Heilbronn (Bristol), Prof. W. V. D. Hodge (Cambridge), Dr. W. Ledermann (Manchester), Prof. M. H. A. Newman (Manchester), Dr. D. Pedoe (London), Prof. H. R. Pitt (Belfast), Prof. W. W. Rogosinski (Newcastle), Prof. H. S. Ruse (Leeds), Dr. F. Smithies (Cambridge), Prof. A. G. Walker (Sheffield), Prof. J. H. C. Whitehead (Oxford), and Prof. E. M. Wright (Aberdeen).

Applied Electronics for Spectroscopists

DURING the week of July 23–30 a summer school on "Applied Electronics for Spectroscopists", sponsored by the Photoelectric Spectrometry Group, was held at University College, Southampton, by arrangement with the professor of electronic engineering, Prof. E. E. Zepler, and the professor of physics, Prof. A. M. Taylor, who with their staff gave generous help. Mr. C. G. Cannon was organiser for the Group. The syllabus was designed to meet the needs of spectroscopists requiring electronic techniques, and of electronic engineers who have to design suitable equipment. Its value was confirmed by the very good attendance. Lectures and demonstrations were given by Prof. Zepler, and by Messrs. S. W. Punnett, T. B. Tomlinson and G. H. Johns, of the University College. Prof. A. M. Taylor gave an introductory talk on the research in progress in the Physics Department, which stimulated many informal discussions. Three members of the Group, Messrs. P. Popper (Mitcham Works, Ltd.), J. C. O. Rochester (Sir Howard Grubb, Parsons and Co.), and E. Schwarz (Hilger and Watts, Ltd.), also contributed lectures on special subjects. A full account of the summer school will appear in the *Photoelectric Spectrometry Group Bulletin*, and it is hoped eventually to issue the complete notes of the course in book form.

Electrical Power System Analysis

A COURSE of lectures and discussions dealing with power system problems and with the analytical methods available for solving them was held in the Electrical Engineering Department of the Imperial College of Science and Technology, London, during the week September 19–23. The course was attended

by seventy electrical engineers, of whom twelve came from universities and electrical undertakings abroad. In his opening address Colonel B. H. Leeson, director of the British Electrical Manufacturers' Association, referred to the importance of periodically taking stock of progress, and of preparing a co-ordinated plan for further development and research. Mr. F. J. Lane, of the British Electricity Authority, considered practical problems to be faced in developing a power system, and this was followed by a review of practical methods for performing network calculation by Mr. C. H. Lackey, of Messrs. A. Reyrolle. The latest analytical methods for the determination of the circuit parameters of overhead lines, underground cables, transformers and loads were reviewed by Mr. L. A. Gosland, of the Electrical Research Association; and Dr. J. R. Mortlock, of the British Thomson-Houston Co., Ltd., discussed the theories used in determining equivalent circuits for alternators. A review of the most useful methods of determining the steady-state and transient power limits of networks was given by Mr. G. W. B. Mitchell, of Messrs. Merz and McLellan, and this was followed by a visit to the A.C. network analyser of Associated Electrical Industries at Willesden. A lecture on methods of solving complex simultaneous equations by Mr. M. W. Humphrey Davies, of the Imperial College, advocated greater use of computing machines for the simpler problems in system engineering work. Finally, Mr. F. J. Lane discussed the effect of some of the economic and technical considerations which it had not been possible to include in the course. In concluding, Prof. Willis Jackson stressed the need for increased co-operation between the universities, the technical colleges and industry to ensure wider dissemination and better utilization of the results of research already performed, and to stimulate the development of improved methods of analysis.

American Pectoral Sandpipers in Britain

In the autumn of 1948 a miniature invasion of American pectoral sandpipers (*Calidris melanotos*) occurred in Great Britain. Birds were recorded in nine different localities including Scotland, Cornwall and the east and west Midlands (*British Birds*, **42**, No. 5; May 1949). It is difficult to state whether the immigration was due to anything unusual in wind or other conditions because of the scattered nature of the occurrences both regarding date and place. The pectoral sandpiper breeds in north-eastern Siberia as well as in arctic America and has been met with, though not positively proved to breed, as far west as the Taimyr Peninsula. The Taimyr is the nearest regular breeding ground of the knot (*Calidris canutus*), which visits Western Europe in great numbers, and this has raised the question whether some of the pectoral sandpipers visiting the British Isles may not come from Siberia rather than across the Atlantic from America. That some do come from America is suggested by the fact that half of the records from the west of England come from the Scilly Isles; this conclusion is strongly reinforced by the several occurrences in the west of Ireland and the virtual absence of records from the Continent. The supposition that some of the visitors come from Siberia is supported by the fact that there are about twice as many records for the eastern part of England as for the west.

Scottish Needs in Building Research

The Scottish Laboratory of the Building Research Station, which is at Thorntonhall, near Glasgow, is now partly completed, and a nucleus of staff has begun work there. In connexion with this, a one-day conference on "Scottish Needs in Building Research" is to be held on October 6 in the Rankine Hall of the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. Apart from imtroducing the new Laboratory, the purpose of the conference is to provide a forum from which Scottish members of the building industry can express their views on Scottish building problems which need research. Admission will be by ticket, and further details can be obtained from the Director, Building Research Station, Garston, Watford, Herts.

Conference at Edinburgh on Elementary Particles

Prof. Niels Bohr will deliver the Gifford Lectures at the University of Edinburgh on Mondays, Wednesdays and Fridays, October 21–November 11, his subject being "Causality and Complementarity". Following this a conference on elementary particles will be held in the Natural Philosophy Buildings, University, Drummond Street, Edinburgh, during November 14–16. Talks so far arranged are as follows: Prof. W. Heisenberg, "Die Erzeugung von Mesonen in Vielfachprozessen"; Prof. L. Jánossy, "On the Production of Mesons by Nucleons"; Prof. H. A. Kramers, "Quantum Electrodynamics and Correspondence-Principle"; Dr. B. Pontecorvo, "On the Decay Products of the μ-Meson"; Dr. J. G. Wilson, "Some New Measurements on the Nature of the Vertical Cosmic-Ray Beam at Sea Level"; Prof. M. Born, "General Theory of Elementary Particles"; Prof. N. Feather, "Experimental Evidence concerning the Possible Existence of the Negative Proton and the Di-Neutron"; Dr. K. C. Cheng, "Reciprocity Theory of Electrodynamics". Other participants will include Profs. F. Bopp, M. Fierz, L. Leprince-Ringuet, C. Møller, C. F. Powell, A. Proca and Dr. H. O. W. Richardson. All interested may attend and should inform Mr. A. Nisbet, Department of Mathematical Physics, University, Drummond Street, Edinburgh 8, who will assist in finding accommodation on request.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have been recently announced. G. F. Godden, agricultural officer, Nyasaland; R. G. Hampson, agricultural officer, Uganda; L. J. C. Wells, agricultural officer, Kenya; D. W. G. Bacon, assistant conservator of forests, Uganda; C. O. Baker, geologist, Sierra Leone; J. W. Barnes, geologist, Uganda; E. F. Bradford, geologist, Federation of Malaya; J. F. Feakes, geologist, Gold Coast; N. S. Haile, geologist, Sarawak; W. N. MacLeod, geologist, Nigeria; D. Magraw, geologist, Kenya; M. G. D. Rees, geologist, Kenya; E. P. Saggerson, geologist, Kenya; J. Spence, geologist, Tanganyika; G. E. Wilford, geologist, Sarawak; J. R. Gibbs, veterinary officer, Uganda; J. A. C. Stewart, veterinary officer, Tanganyika; W. C. Davies, meteorologist, East African High Commission; T. M. Greenshill, agricultural development officer, Nigeria; D. J. Moorhead, veterinary officer, Tanganyika; A. L. Stwart, metallurgist, Geological Department, Kenya; D. B. Turner, provincial tsetse officer, Tanganyika; J. O. Wadhams, assistant conservator of forests, Northern

Rhodesia and Nyasaland; J. R. Welch, botanist, Tsetse Reclamation Department, East Africa; J. R. Brown (agricultural officer, Nigeria), principal produce officer, Department of Marketing and Export, Nigeria; F. E. Buckley (senior agricultural officer, Nigeria), principal agricultural officer, Nigeria; A. de K. Frampton (State agricultural officer, Federation of Malaya), agricultural adviser, Development and Welfare Organisation, West Indies; D. M. Hanschell (botanist, Barbados), sugar agronomist, Trinidad; D. G. Jones (agricultural officer, Federation of Malaya), agricultural officer, Tanganyika; R. K. Kerkham (senior agricultural officer, Uganda), assistant director of agriculture (special development), Uganda; C. A. Thorold (specialist (plant pathologist), Gold Coast), plant pathologist, Nigeria; J. A. R. Stoyle (assistant Government chemist, Nigeria), Government chemist, Nigeria; H. H. Maugham Brown (assistant conservator of forests, Basutoland), assistant conservator of forests, Tanganyika; P. C. Lancaster (senior assistant conservator of forests, Nigeria), conservator of forests, Nigeria; D. McIntosh (senior assistant conservator of forests, Nigeria), conservator of forests, Nigeria; M. Robson (senior assistant conservator of forests, Nigeria), conservator of forests, Nigeria; J. Smith (senior assistant conservator of forests, Nigeria), conservator of forests, Nigeria; J. E. Taylor (senior assistant conservator of forests, Nigeria), conservator of forests, Nigeria; J. D. Gillett (health inspector, Uganda), entomologist, Uganda; O. M. Royes (assistant statistician, Jamaica), island statistician, Jamaica; C. Subiahmanyam (pathologist, Federation of Malaya), senior pathologist, Federation of Malaya.

The Night Sky in October

FULL moon occurs on Oct. 7d. 02h. 52m., U.T., and new moon on Oct. 21d. 21h. 23m. The following conjunctions with the moon take place: Oct. 17d. 13h., Mars 3° S.; Oct. 19d. 00h., Saturn 1° S.; Oct. 20d. 16h., Mercury 1° N.; Oct. 25d. 04h., Venus 2° N.; Oct. 27d. 21h., Jupiter 5° N. Mercury is in inferior conjunction on Oct. 3, stationary on Oct. 12, and at its greatest elongation west on Oct. 19. The planet becomes a morning star, rising 1h. 40m. and 1h. 25m. before the sun on Oct. 15 and 31, respectively. Venus sets about an hour after the sun on Oct. 1 and 1¾ hours after the sun on Oct. 31, and can be seen in the western sky in the evening, stellar magnitude − 3·7, the visible portion of the illuminated disk varying from about 0·7 to 0·6. Mars, in the constellation of Cancer, rises at 1h., 0h. 50m. and 0h. 40m. at the beginning, middle and end of the month, respectively, and can be seen in the morning hours, stellar magnitude 1·6. Jupiter, in the constellation of Sagittarius, sets about 23h., 22h. and 21h. 10m. at the beginning, middle and end of the month, respectively, and is visible fairly low in the sky in the earlier part of the night. Saturn is visible as a morning star, its times of rising being 3h. 40m. on Oct. 1 and 2h. on Oct. 31. Occultations of stars brighter than magnitude 6 are as follows: Oct. 14d. 00h. 43·3m., 49 Auri. (*R*); Oct. 29d. 19h. 51·0m., 37 Capr. (*D*); Oct. 29d. 21h. 33·2m., ε Capr. (*D*). *R* and *D* refer to reappearance and disappearance, respectively, and the latitude of Greenwich is assumed. The Orionid meteors are active about Oct. 18 for a few nights, and moonlight will not interfere with the observation of this shower. There will be a total eclipse of the moon on Oct. 6–7, visible at Greenwich, the circumstances of which are as follows:

Moon enters penumbra	Oct. 6d.	23h.	50·1m.
Moon enters umbra	7	01	04·7
Total eclipse begins	7	02	19·5
Middle of eclipse	7	02	56·4
Total eclipse ends	7	03	33·2
Moon leaves umbra	7	04	48·1
Moon leaves penumbra	7	06	02·7

There will be a partial eclipse of the sun on Oct. 21, invisible at Greenwich, beginning at 21d. 19h. 15·1m. in longitude −154° 24′, latitude −15° 19′, and ending at 23h. 09·5m. in longitude 55° 31′, latitude −66° 11′. The magnitude of the eclipse at maximum is 0·964.

Announcements

SIR REGINALD STRADLING, chief scientific adviser to the Ministry of Works, has been appointed dean of the Military College of Science, Shrivenham, in succession to the late Prof. C. H. Lander.

THE Committee on Science and the Arts of the Franklin Institute has recommended the award of the Francis J. Clamer Medal to Dr. W. Hume-Rothery, lecturer in metallurgical chemistry in the University of Oxford, in recognition of his work on the determination and interpretation of the structure and behaviour of metallic equilibrium systems.

MR. R. H. ROWSE, at present a senior principal scientific officer at the Fuel Research Station of the Department of Scientific and Industrial Research, Greenwich, London, has been appointed director of research to Messrs. Smith and Wellstood (The Esse Cooker Co.), of Bonnybridge, Stirlingshire. Mr. Rowse, who is a graduate in physics of the University of London, has for the past twelve years been in charge of work on domestic cooking, heating appliances and fuels, and has been closely associated with the establishing of the Scottish Branch of the Fuel Research Station at Thorntonhall, near East Kilbride.

THE London Scientific Film Society will be showing films in the Royal Empire Society Hall, Northumberland Avenue, London, W.C.2, at 7.15 p.m. on the middle Wednesday of each month during October 1949–March 1950. The first showing will be on October 19 and will include "Nature of Plastics" (colour), "Heating Research for Houses", "Turbo Jet Propulsion" and "Atomisation". Membership costs are 15*s.* for single persons, or 25*s.* for married couples; further particulars can be obtained from the Honorary Secretary, London Scientific Film Society, 34 Soho Square, London, W.1.

THE ninth series of postgraduate lectures, arranged by the Oil and Colour Chemists' Association, will be given by Prof. M. G. Evans at 6.30 p.m. on October 6, 13 and 20 at the Royal Institution, 21 Albemarle Street, London, W.1, the subject of the lectures being "The Design of Experiment: the Development of Experimental Methods and Theoretical Ideas in a Field of Research". Though the talks will be illustrated by reference to studies in the mechanism of chemical reactions, the theme is one of general application in research and applied science. The fee for the course is 10*s.*, and application for tickets should be made to Mr. John Hannaford, Secretary and Treasurer, O.C.C.A., Aldwych House, Aldwych, London, W.C.2.

ERRATUM. In *Nature* of September 24, p. 544, "Effect of Ethyl Alcohol and Carbon Dioxide on the Sporulation of Bakers' Yeast", line 3, for "in 5–50 per cent" read "from 5 to 50 per cent".

FIRST INTERNATIONAL CONGRESS OF BIOCHEMISTRY

THE First International Congress of Biochemistry, initiated by the (British) Biochemical Society, which was held in Cambridge during August 19–25, was opened in the Senate House of the University by the president, Prof. A. C. Chibnall; Viscount Addison, Lord Privy Seal, welcomed the members on behalf of the Government, and Dr. E. C. Raven, the vice-chancellor, on behalf of the University.

More than 1,700 members attended the Congress, representing forty-two different countries. In his opening speech, Prof. Chibnall recalled the work of the Société de Chimie Biologique in organising since 1927 eight congresses for French-speaking biochemists and thus paving the way for the present International Congress.

On August 20 the University of Cambridge held a special congregation to confer the degree of doctor of science (*honoris causa*) on each of the following: Viscount Addison (U.K.), Prof. C. F. Cori (U.S.A.), Sir Charles Harington (U.K.), Prof. K. Linderstrøm-Lang (Denmark), Prof. A. W. K. Tiselius (Sweden) and Prof. J. Trefouël (France).

It was inevitable that, during the week, thoughts should often turn to the late Sir Frederick Gowland Hopkins, who was for fifty years professor of biochemistry in Cambridge and who may be considered the founder of biochemistry in Britain. In Prof. Chibnall's opening address and on many other occasions, tributes were paid to his work and personality. A copy of the book "Hopkins and Biochemistry", specially prepared for this occasion, was presented to each member of the Congress.

The Committee of the Congress had called together an *ad hoc* International Committee, which drafted and adopted the following resolutions:

(1) That after careful consideration of the invitations received from both France and Italy, it is unanimously agreed that the invitation of the Société de Chimie Biologique for the holding of the next International Congress of Biochemistry in Paris in 1952 be accepted with gratitude.

(2) That an International Committee for Biochemistry be now set up. (This committee is composed of eighteen members representing Australia, Belgium, Canada, France, India, Italy, Netherlands, Poland, Scandinavia, Switzerland, South America, the United Kingdom, and U.S.A., with two places kept for Russian members to be nominated by the appropriate authority. Chairman, Sir Charles Harington; secretary, Prof. K. Linderstrøm-Lang.)

(3) That this Committee be instructed to approach the International Council of Scientific Unions with a request for recognition as the international body representative of biochemistry, with a view to the formal constitution of an International Union of Biochemistry, as soon as possible.

These resolutions were passed unanimously by the members of the Congress at the closing meeting.

The enjoyable conditions in which the Congress was held and the smooth running of the organisation was due in the main to the work (with all their helpers) of Dr. E. Baldwin, Prof. F. Dickens and Lieut.-Colonel E. C. Griffin. A great debt of gratitude is owing to these three.

The scientific proceedings of the Congress were divided into twelve sections, running simultaneously: (I) Animal Nutrition and General Metabolism; (II) Microbiological Chemistry; (III) Enzymes and Tissue Metabolism; (IV) Proteins; (V) Clinical Biochemistry; (VI) Structure and Synthesis of Biologically Important Substances; (VII) Cytochemistry; (VIII) Biological Pigments: Oxygen Carriers and Oxidizing Catalysts; (IX) Hormones and Steroids; (X) Chemotherapy and Immunochemistry; (XI) Plant Biochemistry; (XII) Industrial Fermentations. Besides these meetings, three Congress lectures were held. These were given before very large audiences by Prof. C. F. Cori (on "Influence of Hormones on Enzymatic Reactions"); by Prof. M. Florkin (on "Biochemical Aspects of some Biological Concepts") and by Sir Robert Robinson (on "Tryptophan and its Structural Relatives").

The section meetings covered a very wide field and comprised some five hundred communications. The following account of necessity touches upon only a small selection.

In Section I a discussion on dietary factors leading to liver damage (opened by Prof. G. R. Cameron) showed that there are good grounds for hope that these studies of artificially produced liver changes in animals may throw light on human hepatic injury. Two sessions were held on the anæmias. E. Lester Smith outlined methods of isolation of vitamin B_{12} and K. Folkers discussed its chemical and physical properties. Mary S. Shorb, the first successfully to apply the procedure of microbiological assay to this vitamin, gave an account of work in this field. C. C. Ungley and M. M. Wintrobe considered clinical aspects of the role of dietary factors in anæmia. The significance of trace metals in wasting diseases of domestic animals was discussed by D. P. Cuthbertson.

In Section II some new aspects of the adaptive enzyme question were discussed. F. Bernheim described the very rapid acquirement by avirulent strains of tubercle bacillus of the power to oxidize benzoic acid. M. Pollock reported that the adaptive penicillinase of *B. cereus* persists for seven or eight generations when the organism is grown in absence of penicillin. The adaptive enzyme nitratase may be acquired by coliform organisms in absence of nitrate if a complete mixture of amino-acids (casein hydrolysate) is supplied. J. De Ley showed the other side of this picture when he described the preferential loss of adaptive enzymes in organisms grown in nitrogen-deficient media, the constitutive enzymes maintaining much of their activity.

P. C. Lichtstein reported that the prosthetic group of aspartic deaminase is probably a complex of biotin containing also adenylic acid. L. D. Wright described the preparation of a few milligrams of a crystalline biotin complex from four tons of yeast; this material activated the aspartic deaminase system. K. C. Winkler described non-competitive antagonists of sulphanilamide, and D. D. Woods discussed the

interrelationship of *p*-aminobenzoic acid and pteroylglutamic acid with regard to sulphanilamide action. P. D. Mitchell and J. M. Moyle, using *Staph. aureus*, have shown that the first effect of penicillin upon metabolism (occurring very rapidly) is an upset in purine nucleotide metabolism.

In Section III a discussion on acetyl choline esterase centred largely around the specificity and characterization of this important enzyme (Mendel, Augustinsson, Whitaker, J. A. Cohen, Nachmansohn, Feldberg and Rossiter taking part). F. Lipmann contributed observations on the uncoupling by dinitrophenol of oxidation and phosphorylation and discussed the mechanism of generation of phosphate bond energy. D. B. McNair Scott described the use of paper chromatograms to follow the products of the TPN-catalysed oxidation of glucose-6-phosphate by enzyme preparations from yeast and bacteria. Two communications were concerned with attempts to penetrate the mechanism of protein synthesis—that of Ellis, Gillespie and Lindley on a study of the wool root, and that given by Borsook on the incorporation of carbon-14 labelled amino-acids into the proteins of liver, marrow cells and diaphragm. Interesting studies were described on the effects of emotional excitement on brain metabolism (Richter) and of mustard gas and X-rays on bone marrow metabolism (Lutwak-Mann); on hexokinase and phosphatase activity of intestinal mucosa homogenates in relation to sugar absorption (Hele); and on the formation of long-chain fatty acids from acetate in the mammary gland (Folley and French). A session on developmental biochemistry was held, to which contributions were made by Lundblad, Agrell, ten Cate and Niemierko.

In the section on proteins, perhaps the most lively discussion was stimulated by A. Rothen's communication on postulated long-range forces (between antibody and antigen or between enzyme and substrate) acting through a 'screen' of material, for example, polyvinyl chloride. C. Weibull showed that the flagella of the two bacterial species so far investigated (*Proteus vulgaris* and *Bacillus subtilis*) consist almost entirely of a single protein. Fourteen constituent amino-acids have been identified, but tryptophan, cystine (and cysteine), histidine and hydroxyproline are absent. X-ray diffraction studies (showing the α-pattern) and electron microscope studies have been made. The separation and quantitative determination of amino-acids, using chromatography on starch columns (S. Moore and W. H. Stein), and resinous ion-exchangers (Partridge) and microbiological methods (M. S. Dunn) were discussed. By Moore and Stein's method, only 5 mgm. of protein is needed for an analysis of constituent amino-acids. F. Sanger described the extension of his method of end-group assay with 1 : 2 : 4-fluorodinitrobenzene to the separation of peptides by partial hydrolysis. This had made possible the identification of peptide sequences extending from the terminal residue. Desnuelle discussed the importance of the 'nature' and the 'position' of the peptide bond in determining its rupture by acid and by crystalline pepsin.

In Section V, R. Nicolaysen discussed the effects of vitamin D and of phytic acid on calcium absorption as studied in his isolated-loop technique with rats. Sir Edward Mellanby considered the distribution of phytase and the relation of vitamin D to phytase activity. Sessions were included on liver function, kidney function, the sprue syndrome and clinical aspects of protein metabolism.

In Section VI, E. Chargaff described accurate chromatographic methods for the determination of the building units of ribose and deoxyribose nucleic acids. A. R. Todd described two different methods of synthesis of adenosine triphosphate, one of which raises the possibility of its existence in a cyclic form. G. B. Brown gave a communication on tracer studies for the elucidation of pathways of nucleic acid utilization and synthesis in animals. O. Kamm gave an account of the purification and properties of the anti-diuretic hormone of the posterior pituitary, and F. Lipmann of the chemistry and functions of co-enzyme A.

L. Zechmeister showed how molecular shape and stereochemistry control the provitamin-A activity of the various carotenoid pigments of part-*cis* configuration. Considerable discussion was stimulated by two papers on melanin formation (by H. Mason and J. Harley-Mason) and by E. Schlittler's novel and well-founded suggestion that picrotoxinin is best formulated as containing a nine-membered carbon ring system.

In the cytochemistry section the paper by P. C. Koller on cytological criteria in the interpretation of effects of mitotic poisons led to an animated discussion. H. Holter described his results on the distribution of proteolytic enzymes in amœbæ, and D. Richter on the localization of phosphatases, carbonic anhydrase and true choline esterase in cells of the cerebral cortex. P. Mandel found that in prolonged protein starvation there is a great loss of ribose nucleic acid, whereas deoxyribose nucleic acid remains constant; in muscle atrophy after nerve section the same thing occurs. A. Chantrenne gave an account of the work of Brachet, Jeener and Chantrenne on the separation, in a continuous series of sizes, of protoplasmic particles. The smallest contain the highest amount of ribose nucleic acid, and it is suggested that during growth the large granules are built up by the addition of protein (including enzymes) around the small particles. J. Elkes described his work on the X-ray diffraction patterns of nerve preparations under different conditions; and A. C. Fraser reported on histochemical investigations of fat absorption, using the whole rat intestine.

In Section VIII, Roughton, Haurowitz and George each discussed the physico-chemical reactions of hæmoglobin in relation to its structure. The type of arrangement of polypeptide chains within the protein part of the molecule was indicated by Perutz as a result of his X-ray and optical work. B. Chance gave the results of work on the mechanism of action of the hæm enzymes using the extremely fast spectroscopic flow method which he has developed. Theorell reported on the rate of appearance of isotopic iron in cytochrome *c*, catalase and peroxidase. A fruitful collaboration between Australia (R. Lemberg and Rawlinson) and London (Rimington and his colleagues) concerned the detailed structure of the hæm of cytochrome *a*. Tsou spoke on the properties of cytochrome *c*, in which the protein part of the molecule was reduced to a fraction of its former size with the hæm still attached, and E. C. Slater dealt with the mechanism of oxidation of co-enzyme I through the cytochrome system. K. G. Paul discussed the hæm links in cytochrome *c*. C. G. Holmberg and C. B. Laurell have isolated a copper protein, cæruloplasmin, from human and pig serum. D. Fox discussed the carotenoids of marine animals, and G. Wald described the chemical reactions initiated

by the action of light on rhodopsin; the conversion of retinene to vitamin A_1 needs reduced co-enzyme I.

In a joint session with Section III, Davies considered the experimental data on acid secretion obtained from isolated gastric mucosa and (with Ogston) a theory of the mechanism. C. Terner discussed the role of the back diffusion of hydrogen ions in the regulation of gastric acidity.

In Section IX, sessions were held on progesterone metabolism, steroid metabolism, hormones and carbohydrate metabolism, the pituitary gland and (with Section V) on the thyroid gland. C. H. Li and Henly, Morris and Morris discussed the chemistry of the adrenocorticotrophic hormone, and Li also its effects on glycogenesis in isolated diaphragm. C. A. Villee described the metabolism (with and without insulin) of carbon-14 labelled glucose by rat diaphragm *in vitro*, using normal and diabetic animals with and without removal of adrenals or hypophysis or both. Cotes, Reid and F. G. Young considered the relation between growth-promoting pituitary extracts and experimental diabetes. G. Pincus discussed the blood and urine indices of human adrenal cortex function, and described the response to stress and to adrenocorticotrophic hormone in normal, psychoneurotic and schizophrenic subjects.

In Section X the necessity for a protein component in antigen formation was the subject of much discussion. The great technical difficulties in purification of natural antigens came out strongly in the communication of M. Loveless, and M. Heidelberger directed attention to the necessity for accurate methods of estimation of components of immunological systems. In the session on drug resistance, there was discussion of development of resistance in tubercle bacilli to streptomycin (Hart; Trefouël; Schaeffer); and of malarial parasites to 'Paludrine' and sulphadiazine (Bishop). Slonimski outlined studies on the production of mutant strains of yeast by exposure to acriflavine. R. Wurmser gave a mathematical and physicochemical presentation of the reactions involved in hæmagglutination. The nature of the antibody–antigen reaction (Marrack; Haurowitz) was the subject of prolonged discussion.

In the plant biochemistry section, symposia were held on starch, on cell-wall constituents and on photosynthesis. K. H. Meyer discussed amylose and amylopectin, phosphorylase and *iso*-phosphorylase. S. Peat and E. J. Bourne described a different amylopectin system, the Q-enzyme. A. Frey-Wyssling showed electron micrographs of cell walls. The hemi-cellulosic fractions of cell-wall polysaccharides were discussed by Isherwood and lignin structure by H. Erdtmann, by K. Kratzel and by F. F. Nord. R. Hill recounted the identification of two new cytochrome components from the chloroplasts. H. Gaffron and M. Calvin discussed the paths by which carbon-14 labelled carbon dioxide passes in the early stages of photosynthesis; a water-soluble fraction containing the labelled carbon appears after a few seconds of photosynthesis. The results of E. C. Wassink strongly suggested a role of phosphate bond energy in photosynthesis.

In Section XII much consideration was given to the production of penicillin, streptomycin and polymyxin E. Of particular interest was the occurrence of phage infection of *Streptomyces griseus* described by W. L. Koerber. Various aspects of brewing, of yeast production and a number of bacterial fermentations were discussed.

THE GAP BETWEEN SCIENCE AND INDUSTRY

THE discussion on September 5 in Section G (Engineering) of the British Association which followed Sir Arthur Fleming's presidential address to the Section on "Bridging the Gap between Science and Industry", like so many present-day discussions, centred largely on the question of staff. Sir Arthur had emphasized that the rate of industrial progress depends on both the acquisition of new knowledge and its effective use. Most speeches in the discussion were concerned with the question of the effective use, whether of new or of old knowledge, and of the dependence of this upon not merely the scientific or technical but also the managerial staff. Sir Andrew McCance, who opened the discussion, believes that the most serious question is the time taken for ideas already known and accepted by the scientific world to penetrate into that of industry and win acceptance and application. While this may be only a temporary phase, it will persist until every manager receives some technical training before he enters industry and until every scientific worker realizes that in management there is a skill which must be learned like every other skill. Sir Andrew considers that specialization is a main cause of the sluggishness with which scientific methods have been applied to British industry; but he also mentioned one industry in which more than four hundred firms between them employ on their staffs fewer than twenty technically trained men.

Wing-Commander T. R. Cave-Browne-Cave picked up Sir Arthur Fleming's point about the importance of teaching staffs of universities and technical colleges having greater opportunities for maintaining contact with changing industrial practice. He agreed that university lecturers should have effective contact with the real problems of industry for which they are training their students; but no suggestion was advanced in the discussion as to how this is to be achieved, nor was the remark made in the recent Nuffield College report on the giving of technical training within industry rather than before entry put forward in discussion. Wing-Commander Cave-Browne-Cave is sceptical as to the ability of the universities to develop successfully the all-important characteristics of understanding and personality. Mr. J. R. Clarke considers that from the point of view of staffing industry with men trained in science and of receptive minds, those who have had a general rather than an honours or special degree are often more promising material; but the prospects which industry could offer such men if they enter it as technicians required consideration. Dr. E. Marsden, referring to Sir Arthur's observations on the differences between conditions in Great Britain and in the United States, thinks that our industry is organised too much for static conditions instead of for progressive change. The difference between British and American industry in this respect is not a matter of facilities but of method and outlook, and can only be changed by getting men of the right type and of initiative to enter industry.

Dr. B. J. A. Bard, however, laid the chief stress not so much on men as on materials. We have to remember the essential purpose of industrial research, and while the personal qualities of the scientific worker are of vital importance, industrial development in the main comes from the relentless pursuit

of the improvement of existing methods and materials. Something can also be done, he said, to educate the consumer in the use of new materials, and more attention to the relations between consumer and producer is required. This is the reason for the importance of the liaison officers of the research associations, and although Sir Arthur did not himself refer to this aspect of their work, it is related to the operational research which he cited as an outstanding example of bridging the gap between scientific discovery and its practical application. Sir Claud Gibb dealt with the heavy capital cost of development, and the importance of intimate contact between the designer and research worker; but even for the engineering industry, his suggestion that if every research worker had a little more commercial instinct there would be less of a gap between science and industry seems a little naïve and confuses the functions of management and investigation.

While Prof. H. E. Hackett was critical of the training in engineering schools, that aspect was not further pursued in the discussion; but Dr. A. T. Bowden strongly supported Sir Andrew McCance's remarks on the importance of scientific and technical knowledge at the managerial level; the main problem, he said, is not so much one of new materials as of making better use of existing materials. This was a main theme of Sir Henry Tizard's remarks in concluding the discussion. Sir Henry said that there was very little in Sir Arthur Fleming's address with which he would disagree; he expressed the view that we are unlikely to be far behind when it comes to industrial application in the study of nuclear phenomena: if we were, it would be due not to shortage of experienced scientific men, as Sir Arthur suggested, but rather to the shortage of engineers with the right kind of education.

Sir Henry then returned to the theme of his presidential address to the Association last year. Unless we can hasten the application of science to industry in Britain, we shall cease to count among the great nations of the world. We can only escape disaster if we make things better and cheaper, and if we are bold and adventurous in industry. There must be changes, and on a big scale, if we are to recover our balance and maintain our standard of living. Nevertheless, the need for extending facilities for fundamental research, he said, needs no emphasis; in quality and quantity, fundamental research in Great Britain is unsurpassed in any other country, and it is true to say that fundamental knowledge is being acquired faster than it can possibly be applied in industry.

To secure the more effective utilization of existing knowledge is partly a matter of education—of scientific and technical education in all branches and of education for management. That, however, is a slow process, nor did Sir Henry suggest that the industrial research associations as yet provide the right answer and are able to meet the needs of the hundreds of small industrial units unable to support extensive research laboratories individually and often managed by those who are not likely to understand scientific reports. Even large industrial units are sometimes reluctant to embark on adventurous projects, possibly because they are not prepared to risk the capital expenditure on development. Sir Henry suggested that the possible deterrent effect of fiscal laws on development is a subject worthy of dispassionate discussion between sections of the Association. He is convinced that we must find a way of spending far more on development, large-scale application and re-equipment than we have done in the past. It is almost useless to extend the facilities for scientific and industrial research unless we are prepared to take promising results a stage further. It may be that the ability and willingness to finance new and unproved developments and processes, rather than the volume of research, really determine the rate of application of science to industry, and Sir Henry sees in the study of the capital equipment of British industry and of its rate of obsolescence a useful field for combined effort by engineers and economists.

TECHNOLOGY AND THE HUMANITIES

FOLLOWING the presidential address to Section L (Education) of the British Association, delivered on September 2 by Sir Fred Clarke, a discussion took place on "Technology and the Humanities in Further Education". This was introduced by two short papers on the subject, one by Prof. A. F. Burstall, of King's College, Newcastle, who spoke from the academic point of view, and a second by Mr. K. R. Evans and Mr. B. J. Crowther, of Metropolitan-Vickers Electrical Co., Ltd., Manchester, who spoke as industrialists. The authors of both papers were emphatic that the further education of the technologist should include the humanities as well as advanced technology; both were equally insistent that the character and personality of the teacher are all-important to success.

The first paper was devoted to considering what is being done, and could be done, for undergraduates destined for a career in industry. Prof. Burstall described how some humanities have been introduced into the final year of one of the engineering degree courses at Newcastle; the new course includes some special lectures for engineers on economics, accountancy, industrial health and industrial psychology given by the professors of those subjects, as well as lectures on factory management and a course of technical report writing. The results indicate that this kind of work tests some other quality of mind which is not tested by examining in technical and scientific subjects, since there is no correlation between the marks in these special subjects and those in the others.

Prof. Burstall concluded that since the standard in mathematical subjects of an engineering degree course is continually rising, and there is a growing insistence upon the possession of a university degree for so many posts in industry and Government, there is a danger that ultimately all engineering work will be dominated by mathematical minds. He thought this would not be a good thing. "There may be men of character and of value to the engineering profession who cannot stomach the mathematical discipline—they may be fascinated by engineering work and determined to succeed at it, some having the creative type of mind that is often undisciplined, others administrative ability amounting almost to genius. Are these men to be deprived of a university education?" He thought that some alternative courses should be offered for those who cannot achieve the standard in mathematical discipline now required at the universities. "The question is what other discipline can be substituted for the mathe-

matical one without lowering the standard?" His own preferences are for logic, economics and psychology, or for a training in creative work—design or construction. Possibly all these could be combined with some engineering studies; but almost inevitably the length of time required to achieve a reasonable standard would be longer than is needed for a training in the mathematical technique.

He explained the practice of the University of Durham in admitting a small number of students to the engineering courses each year who had the Higher National Certificate in Mechanical Engineering as their qualification for admission. Some of these students had been very successful, but the greatest difficulty they presented was how to select the best of those who apply for the small number of places available.

Those who advocated making management a closed profession like the medical profession wish to see university degrees in management made a compulsory requirement for anyone holding a managerial position. The universities have not responded enthusiastically to the suggestion that they should provide courses in management, and there is little or no provision for those who intended to make management studies their postgraduate work.

The best solution Prof. Burstall could offer for bringing together technology and the humanities in further education was a combination of four main studies over four years: (1) philosophy (logic and ethics); (2) economics (including the principles of accounting); (3) the principles of physical science (mostly applied science, including machine drawing and some laboratory work—taught with the minimum of mathematics); and (4) biological science, with emphasis on public health, safety and industrial psychology. Such a training ought to make the successful candidate worthy of a bachelor's degree.

Mr. K. R. Evans and Mr. B. J. Crowther were concerned not only with university graduates in engineering but also with other apprentices, including trade apprentices, to whom further education is given during their works apprenticeship. They asserted that practical experience in the humanities is gained by apprentices in the course of their human relationships in the works, especially in running the apprentice associations. These are administered by elected apprentices who receive only guidance from the staff of the works education department. They administer the social, recreational and athletic activities of the association and produce their own magazine. Senior apprentices also take part in assessing applicants for apprenticeship when they visit the works for interview.

Messrs. Evans and Crowther also described the teaching of social and economic history as valuable to apprentices, and said it is best approached through the history of engineering, particularly that of the local industrial area. The selection of subjects for further education of the manual or unskilled worker is a difficult problem. "Those industries in which the manual operations are repetitive and whose management grades are less likely to be derived from those who started their working life as manual workers, will find more difficulty in instigating formal or informal studies in cultural and non-technical subjects, not necessarily because the workers lack intelligence or even basic education, but because there exists no ready-made study interest on which to build."

They recommended sending young workers for a short period for a residential course, such as that given at Rugby School. The selection should be made not from those who would be a credit to the company, but from the type of young person who is in need of just such an experience.

During the ensuing discussion, it was suggested that justice had not been done to the technical colleges, which had scarcely been mentioned, though in many places they are becoming local colleges of education rivalling the universities in the variety of subjects taught. One principal of such a college thought they did much to bring the humanities and technology together in further education, and appealed for a wider development of residential facilities, so that the technical colleges could extend this side of their work. There was general agreement that the conventional type of engineering course does not develop the qualities most needed in administrative work, and one speaker referred to the present difficulty of finding suitably qualified men to occupy posts in the higher levels of administration, particularly in the nationalized undertakings.

There was a marked difference of opinion about interesting students of technology in art, music and literature. Some had been unsuccessful in their attempts to do this, and had given it up; another referred to outstanding success in this endeavour achieved by the Scandinavian colleges. One speaker asserted that pure science is just as effective as logic in teaching a student how to think. This was challenged by a later speaker, who referred to the report on "Transfer of Training" published by Section L of the British Association in 1930.

Several speakers mentioned that students of languages and of the arts would be all the better for some knowledge of technological matters.

CONVERSION OF MANNITOL AND SORBITOL INTO DULCITOL

By Dr. P. BLADON and Dr. L. N. OWEN
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AND
Dr. W. G. OVEREND and Dr. L. F. WIGGINS
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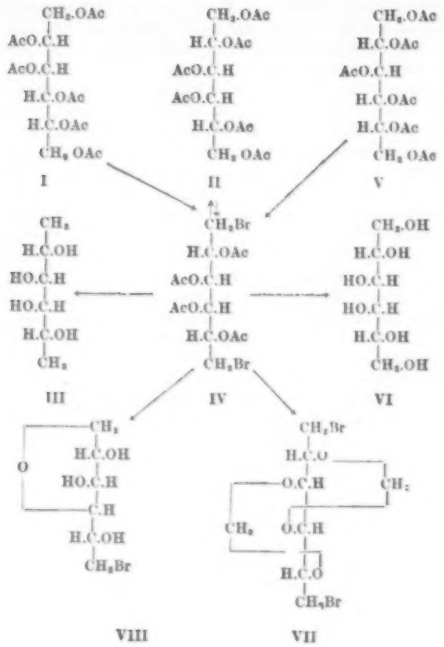
In a recent publication[1], the preparation of 1 : 6-dithiomannitol is described. In subsequent attempts to obtain this dithiol by other routes, two of us (L. N. O. and P. B.) have treated 1 : 6-ditosyl 2 : 5-diacetyl 3 : 4-*iso*propylidene mannitol[2] with potassium thioacetate in boiling acetone, a reaction which has been shown[3] to result in the replacement of tosyloxy- by acetylthio-groups. Removal of the acetyl and acetone residues from the product gave crude 1 : 6-dithiomannitol, m.p., 120–135°, the hexa-acetyl derivative of which had m.p. 109–111° $[\alpha]_D^{18°}$ + 85·0° (all rotations in chloroform). This was clearly not identical with the previously described hexa-acetyl 1 : 6-dithiomannitol of m.p. 188°, $[\alpha]_D^{18°}$ ± 0°.

The latter material had been prepared by the action of potassium thioacetate on the so-called tetra-acetyl 1 : 6-dibromo 1 : 6-dideoxymannitol of Vogel[4], and since it was unlikely that any abnormal reaction could have occurred at that stage, it was decided to investigate the structure of Vogel's



dibromide. This compound (m.p. 197–199°) was prepared by Vogel's method (action of hydrogen bromide in acetic acid on hexa-acetyl mannitol (I) for several months at room temperature), and by the more convenient method of warming the reaction mixture for ten hours at *c.* 40°. Particular care was taken to ensure the purity of the mannitol used for the preparation of the hexa-acetate, the commercial product being purified by regeneration from its tri-*iso*propylidene derivative. The dibromide so obtained, on reaction with potassium acetate in acetic acid – acetic anhydride solution, gave hexa-acetyl dulcitol (II), m.p. and mixed m.p. 168–169°, in more than 90 per cent yield. Furthermore, hydrogenation of the dibromide over Rapey nickel gave tetra-acetyl 1 : 6-dideoxydulcitol, m.p. 182–184° (found : C, 52·8 ; H, 7·2. $C_{14}H_{22}O_8$ requires C, 52·8 ; H, 7·0 per cent), which on deacetylation yielded the known 1 : 6-dideoxydulcitol (III)[5], m.p. 185° (di-*iso*propylidene derivative, m.p. 63–64°), whereas with sodium iodide in acetone solution the dibromide furnished tetra-acetyl 1 : 6-di-iodo 1 : 6-dideoxydulcitol, m.p. 188–190° (decomp.), (found : C, 29·4 ; H, 3·8. $C_{14}H_{20}O_8I_2$ requires C, 29·5 ; H, 3·5 per cent). This evidence proves beyond doubt that Vogel's dibromide is actually tetra-acetyl 1 : 6-dibromo 1 : 6-dideoxydulcitol (IV), and it must therefore be identical with the compound described by Wolfrom *et al.*[6]. The optical rotation recorded by Vogel is erroneous ; the dibromide and all the above compounds derived from it are optically inactive, in conformity with the dulcitol configuration. The original '1 : 6-dithiomannitol' obtained from Vogel's dibromide is therefore 1 : 6-dithiodulcitol.

In view of these rather surprising results, it appeared to be very probable that the compound, m.p. 196°, prepared by the action of hydrogen bromide in acetic acid on hexa-acetyl sorbitol (V), and assumed to be a sorbitol derivative[1], also had the same structure (IV). This proved to be so, the product being identical with that obtained from hexa-acetyl mannitol (I) ; the same substance was also obtained by a similar reaction on hexa-acetyl dulcitol (II). The yields of (IV) from the hexa-acetates of mannitol, sorbitol and dulcitol were respectively 23, 25 and 58 per cent.

A similar conclusion with regard to the constitution of the Vogel dibromide has been reached independently (by L. F. W. and W. G. O.) in the Chemistry Department of the University of Birmingham. It was found that the dibromide prepared according to the conditions of Vogel contained two bromine groups attached to primary carbon atoms, since reaction with sodium iodide in acetic anhydride solution rapidly took place (45 min.) with the formation of tetra-acetyl 1 : 6-di-iodo 1 : 6-dideoxyhexitol (*A*) (m.p. 188–189°). The acetyl residues were also replaceable by two methylene groups on treating the original dibromide with paraformaldehyde and concentrated sulphuric acid. Dimethylene 1 : 6-dibromo 1 : 6-dideoxyhexitol (*B*) was formed. When the Vogel dibromide was treated with sodium methoxide, a small yield of a crystalline anhydro hexitol monobromohydrin (m.p. 143°) was obtained, and this proved to be identical with the dulcitan monobromohydrin (*C*), which Maquenne[7] describes as being obtained by the hydrolysis of dulcitol dibromohydrin. Final proof that the Vogel dibromide was indeed tetra-acetyl 1 : 6-dibromo 1 : 6-dideoxydulcitol was obtained when it was hydrolysed with aqueous hydrobromic acid. Dulcitol (VI) itself was isolated and characterized by means of its melting point and by conversion to hexa-acetyl dulcitol. Thus (*A*) is tetra-acetyl 1 : 6-di-iodo 1 : 6-dideoxydulcitol, and (*B*) is dimethylene 1 : 6-dibromo 1 : 6-dideoxydulcitol, probably represented by (VII). The dulcitan monobromohydrin (*C*) is probably 1 : 4-anhydro 6-bromo 6-deoxydulcitol (VIII).

The remarkable conversion of the mannitol and sorbitol configurations directly into that of dulcitol has not been previously reported in the literature and is of considerable theoretical interest. It suggests that, under the conditions of this reaction, Walden inversion can occur at all the asymmetric centres, giving rise to a mixture of hexitol derivatives of various configurations. The ready isolation of the tetra-acetyl 1 : 6-dibromo 1 : 6-dideoxydulcitol is undoubtedly due to its relative insolubility, by virtue of which it is precipitated during the reaction in almost pure form. It is probable that the liquid portion of the reaction mixture contains hexitol derivatives of other configurations. The fact that Vogel quoted $[\alpha]_D^{18°} + 10{\cdot}26°$ for his dibromide may possibly be explained by the presence of these isomers as impurities in his material.

It is not unlikely that the tetra-acetyl dichloro dideoxymannitol of Fischer and Armstrong[8] (m.p. 214°), obtained by the action of liquid hydrogen chloride on hexa-acetyl mannitol, is a dulcitol derivative. This is certainly different from the tetra-acetyl 1 : 6-dichloro 1 : 6-dideoxymannitol of Griner[9], and this material must be a true mannitol derivative because it has been obtained simply by the acetylation, under mild conditions, of 1 : 6-dichloro 1 : 6-dideoxymannitol, which, by the work of Haworth and Wiggins[10], is without doubt a mannitol derivative.

Further work on this interesting reaction is now in progress, and fuller details will be published elsewhere. One of us (P. B.) wishes to thank the Depart-

ment of Scientific and Industrial Research for a maintenance grant, and two of us (L. F. W. and W. G. O.) wish to thank the Colonial Products Research Council for financial support.

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ECLIPSE OBSERVATIONS OF SOLAR RADIATION AT A WAVE-LENGTH OF 50 CM.

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THE solar eclipse of November 1, 1948, was visible in its partial phases over most of Australia. Observations of radio-frequency radiation at a wave-length of 50 cm. were made at three sites to determine the distribution of radio brightness over the solar disk and also to investigate possible polarization effects associated with solar magnetic fields.

Previous work[1,2,3] at decimetre wave-lengths has suggested that the radiation may be divided into : (*a*) a thermal component from the 'quiet' sun, and (*b*) a component which is correlated with sunspot area. Theoretical considerations[4], based on the probable existence of temperatures around 10^6 °K. in the corona, suggest that the first component should show 'limb-brightening' at these wave-lengths. A solar eclipse provides an opportunity of testing this prediction. It has been suggested[4] also that a general magnetic field on the sun should produce an inequality in the circularly polarized thermal components of the radiation from each hemisphere. The circumstances of this eclipse were such that one hemisphere only was visible at the maximum phase, and this favoured the detection of such an effect.

The flux density of radio-frequency power from the sun was measured during the eclipse at Sydney (New South Wales), Rockbank (near Melbourne, Victoria), and Strahan (Tasmania). The results are shown in Fig. 1. At each place, departures from a smooth curve were found in the record. These appeared to be caused by the eclipsing on the sun of small areas that had a greater radio brightness than their background. A similar effect has been noted at a wave-length of 10·7 cm. by Covington[5].

The positions of these small bright areas were determined as follows. The times at which the magnitude of the power flux density changed most rapidly were found from the records. It was inferred that at these times the edge of the moon passed over a bright area. The apparent positions of the edge of the moon's disk with respect to the solar disk at these times were known for each station, and hence the position of each bright area could be indicated by a circular arc. At the three observing stations the apparent path of the moon was markedly different, and arcs for one station therefore intersected those for the other observing stations. The point of intersection of appropriate arcs indicated the position of a bright area. Such intersections are shown in Fig. 2. Of the eight bright areas denoted by full circles in Fig. 2, seven were found close to the positions of optical features on the disk : (*a*) three coincided in position with visible sunspot groups (three other sunspot groups showed no associated bright area) ; (*b*) three were found close to the positions occupied by sunspot groups 27 days previously ; (*c*) one was found at a distance of roughly $1{\cdot}7 \times 10^5$ km. outside the limb of the disk and close to a solar prominence (one other prominence which was eclipsed showed no associated bright area).

In two instances the interpretation of the intersections was ambiguous and the location corresponding to the closest intersection was selected. One doubtful location is shown enclosed by the dotted circle on the left of Fig. 2. This area was eclipsed only at Strahan and is defined by the intersection of two arcs only, one corresponding to the covering and one to the uncovering of the area.

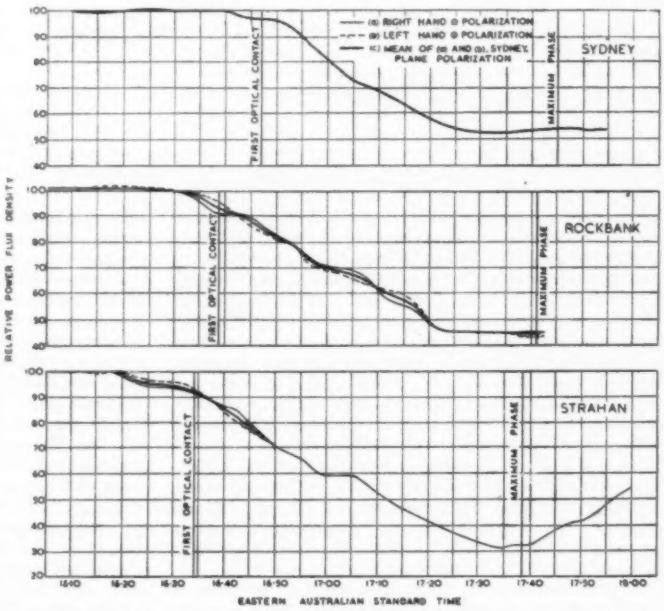

Fig. 1. Records taken at three places showing changes in power flux-density during the eclipse

A study of the records revealed that the bright areas contributed roughly 20 per cent of the measured radiation from the sun. The effective black-body temperature of each bright area was estimated from the duration and magnitude of the irregularities in the records, and from an assumed equivalent black-body temperature (referred to the visible solar disk) of $0{\cdot}5 \times 10^6$ °K. for the 'quiet' sun. The average temperature was found to be 5×10^6 °K., while some areas had an effective temperature probably exceeding 10^7 °K. After allowance had been made for the effects of the small bright areas, the distribution of the residual brightness over the disk was considered. This was presumed to be associated with the thermal component (mentioned earlier) of the solar radiation.

The interpretation of the records showed that roughly half the (presumably) thermal component of the radiation originated close to, and predominantly outside, the edge of the visible disk of the sun. The details of the brightness distribution could not be derived from the records. The latter were shown to be consistent with two tentative distributions, the first a theoretical one, involving limb brightening, derived by Smerd[6] (similar to that of Waldmeier and Müller[7]), and the second a uniform one over a disk having 1·3 times the diameter of the optical disk of the sun. The existence of limb brightening, therefore, was not proved.

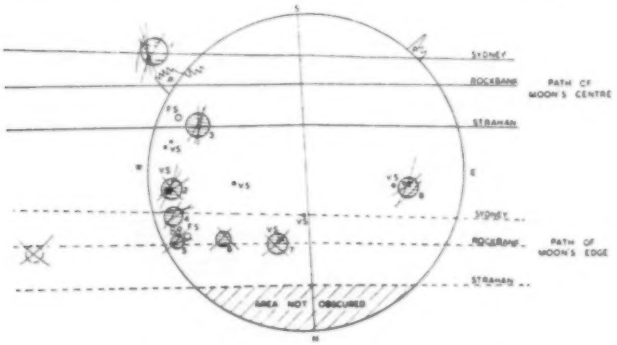

Fig. 2. Positions of small bright areas (numbered) on the solar disk, as deduced from intersecting arcs. V.S., visible sunspot groups; F.S., position of sunspot groups 27 days before eclipse; F, prominences

During the eclipse, the magnitudes of the two circularly polarized components of the solar radiation were compared. Relative changes were found during the eclipsing of some of the bright areas (particularly in the case of area No. 1 of Fig. 2). The magnitudes of the components tended to return to equality after such changes. During the eclipsing of the southern hemisphere of the sun, no tendency greater than the observational uncertainty of about 3 per cent was found for one polarized component to predominate. Comparing this figure with a theoretically derived value for the percentage polarization due to a general magnetic field on the sun, S. F. Smerd of this Laboratory calculated that at the time of observation the equivalent central dipole moment of the sun was less than $1{\cdot}4 \times 10^{18}$ gauss km.^{3}. This corresponds to an upper limit of 8 gauss for the surface field-strength at the pole.

A full account of this work, which is part of the research programme of the Radiophysics Laboratory, Commonwealth Scientific and Industrial Research Organization, Australia, will be published elsewhere.

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CARNEGIE UNITED KINGDOM TRUST

ANNUAL REPORT

THE thirty-fifth annual report of the Carnegie United Kingdom Trust covers the year ended December 31, 1948, and records for the second year in succession an excess of total expenditure, £143,000, over expendable income, £132,000, in accordance with the deliberate policy of compensating for reduced activity during the War. Much of the report is occupied by accounts of the village hall schemes and land settlement work which, having won recognition as parts of the permanent social structure of Britain, have now been removed from the sphere of operations of the Trust and became, during the year, the responsibility of Government departments. The Development Commissioners have agreed to accept sole responsibility for the loan fund for village halls; but the trustees have decided to allow their offers of grant to remain open until the last year of their next following quinquennium, 1955. The Trust's experimental work in the field of land settlement is regarded as finished with the passing of the Agriculture Act of 1947 in England and Wales and the corresponding enactment of 1948 in Scotland, and the Minister of Agriculture took over the Trust's properties and financial responsibility for welfare work on April 1, 1948.

A new grant of £750 a year for three years was made to the National Union of Townswomen's Guilds, and a further grant of £700 for development work on women's institutes in the Channel Islands. A grant of £15,000 was made to the Belfast Council of Social Welfare for a social service centre which provides headquarters for the principal voluntary social service organisations operating in Northern Ireland. A maintenance grant on a diminishing scale for five years from the date of transfer has been promised to the Irish Central Library. This will require a further £9,000. It is hoped that the Scottish Central Library will be similarly transferred to an independent governing body during 1949. A new grant of £2,000 was made to the National College of Teachers of the Deaf for experimental work on the preparation and publication of books specially designed for teaching deaf children to read. Another new grant, of £2,500, was to the Severn Wildfowl Trust for the provision of new or improved facilities for students at the bird sanctuary known as the New Grounds. An agreement was reached between the governors of the Trust and the Scottish Leadership Training Association under which Newbattle Abbey is to provide from February 1949 to June 1950 residential and tutorial

accommodation for students attending the Association's courses of professional training for community centre workers and youth leaders.

In the field of youth services, a principal event of the year has been the revival of a project for a residential clinic for difficult children, towards which the trustees have offered at least £5,000. This experiment, with the five-year investigation being financed at the Philanthropic Society's School at Redhill, is regarded by the Trustees as a piece of pioneer work in juvenile delinquency which may suggest new methods of dealing with young delinquents.

EDUCATING MEN OF SCIENCE

FOUR American men of science, representing the different departments of physics, social relations, mathematics and biostatistics, have been considering the problems and difficulties arising from over-specialization in science ("The Education of a Scientific Generalist", by Henrik Bode, Frederick Mosteller, John Tukey and Charles Winsor; *Science*, 109, June 3, 1949). These difficulties, they state, are most pressing in the borderline fields like physical chemistry, biophysics, biochemistry and the application of chemistry, physics and mathematics to medicine, and have led to a position where there is too much narrow specialization in which "one man can no longer cover a broad enough field". Yet, at all levels, decisions have to be made which involve consideration of more than a single field of science and indicate the need for a simpler, more unified approach to scientific problems. "We need men who can practise science—not a particular science—in a word, we need scientific generalists."

Before elaborating details of the training which they would suggest for scientific generalists, the authors indicate that the unification of science may reasonably start from the following ideas:

1. All science began as part of 'natural philosophy' and radiated outward. Even to-day it should be possible to recapture the universalist spirit of the early natural philosophers.

2. Scientific method is common to all sciences.

3. Almost every science is more easily taught by using some of the equipment of the others. (This is generally admitted to be true for mathematics in physics, less generally for chemistry and physics in biology, to name two examples.)

4. Statistics, as the doctrine of planning experiments and observations and of interpreting results, has a common relation to all sciences.

5. Unification will be more easily attained if the logical framework of the individual sciences can be identified and isolated from their factual content.

From this preliminary attempt to unify science, the authors discuss the kind of background which should be given to undergraduates to help them develop into scientific generalists. The scientific generalist is considered to be a man with training and a working sense in many fields of physical and biological science. His principal interests may be broad or sharply defined; but he is exceptional in his breadth of appreciation. He may be working in pure science, or in the application of science to engineering, business or industry. He may not be as good a physicist as a student who has been trained principally in physics, or as good an economist or engineer or psychologist as a specialist in those fields. But he has learned enough of these fields, and of the central tools of mathematics and statistics, to bring to problems of almost any kind the ideas and broad tools of any combination of these many subjects which will speed and improve the work.

Such men are needed as members of research teams, while any first-class administrator or policy-maker in fields related to science must be a generalist to a considerable degree. The value of such men was seen during the Second World War, when men of science who were able to carry over and apply their methods of thought to fields other than their own were able to assist largely in the solution of military problems. Examples of the way in which such men have successfully tackled problems in the social sciences, economics, engineering, biological and medical science are also given.

During his four undergraduate years such a man should be given a broad foundation to open his mind to a wide range of scientific fields. On graduation he should go on with further studies which, at present, would presumably be in some special field but, eventually, might consist of postgraduate training as a generalist.

The education of a scientific generalist using present-day courses or those developed in the future must be based on at least three main principles. First, the pregeneralist must study many fields of science deeply enough to understand their logical framework and the approaches of their practitioners. Secondly, with the possible exception of a few tool subjects, the interest of the pregeneralist in factual information is of secondary importance. Thirdly, omitting all prerequisites is to be encouraged.

The training course itself would be split up into short courses, of which there would be four in biology, chemistry and statistics, six in mathematics and physics, two in psychology and English, and one each in industrial processes, 'judging' and surveying. There would also be eight courses in related subjects like history, philosophy, economics, the humanities and social sciences. 'Judging' would consist of a specially devised course to include the use of scientific method and aimed to help the student to bring his intelligence and education to bear on estimation and prediction, problems for which he has inadequate information.

The kinds of courses indicated under each main subject are suggested and, in biology for example, would include cellular biology or general physiology (from the point of view of transfer of energy, intermediary metabolism, physiology), comparative anatomy (from the developmental and truly comparative point of view), the problems of genetics (persistence and change of hereditary patterns), and evolution and evolutionary record. In physics the courses would include elementary physics, electricity, physical measurements and one or two advanced optional subjects. Psychology would include one course in experimental psychology, including laboratory work, and one in systematic psychology consisting of a study of psychological problems and theories with some emphasis on methodology and classic experiments.

The surveying course would be carried out in the summer term and, in addition, the students would then be required to reach proficiency in two languages useful for scientific purposes, preferably by study in the countries concerned. During the four years students would also be required to carry out two pieces of independent work, one dealing with economic problems and the other involving two or three different fields of science.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Wind and Temperature Measurements up to 30 Km.

In a letter in *Nature* in 1946 Sir Nelson Johnson[1] reported some results of direct measurements of winds at 30 km. by means of observations of shell bursts. Exploration to this height by means of sounding balloons has recently become possible through the development of balloons of large size. Measurements of wind structure are made by radar tracking, and temperature observations are given by *radio sonde* technique. Seven successful ascents have been made at stations in the south and east of England; five of them were made in midsummer and at night, thus avoiding possible temperature errors due to solar radiation. The other two were day-time ascents in spring, and were confined to wind measurements only. The results of two of the soundings are illustrated in the accompanying diagram.

Between 15 km. and 20 km., all the soundings showed a veer of more than 100° in wind direction and also a minimum in wind speed. From these heights up to 30 km., easterly winds prevailed in all the summer ascents and also in the April one, whereas in the March sounding the upper wind was from a westerly quarter. Good confirmation is thus provided for the 'monsoon wind' theory of the late Dr. F. J. W. Whipple[2] who, from the anomalous propagation of the sound of explosions, deduced that the wind at high levels changes from west to east at the end of March and back again to west in the middle of September.

The chief feature of the temperature soundings is the steady rise with height in the stratosphere from a mean of −54° C. at 18 km. to −40° C. at 30 km., that is, a gradient of about 1° C. per km. These temperatures are about 16° C. lower than the day-time temperatures at the same levels in England calculated by Gowan[3] from the effect of absorption of radiation in the ozonosphere under radiative equilibrium conditions. The large difference can scarcely be due to the fact that the soundings were made at night, for Gowan also calculated that the cooling of the ozonosphere during the night should not amount to more than about 3° C. at 30 km.

Three of the five temperature soundings showed double minima, the lower one being at the normal tropopause height of 12 km. and the other at about 17 km. These features can be interpreted as a discontinuity in the tropopause of the type first suggested by Bjerknes and Palmen[4,5]. According to Hess[6], the discontinuity between an upper, tropic tropopause and a lower, arctic one occurs between latitudes 50° and 52° in North America in summer. It could, therefore, be expected to show up frequently in high soundings in England. Moreover, since the discontinuity is associated with the occurrence of a narrow zone of fast-moving air, which has recently come to be known as a jet stream, some evidence of this in the shape of a sharp maximum in wind speed near the lower level tropopause could also be expected. Some of the soundings did, in fact, show such sharp maxima.

Further details of the recent observations are being published in the *Meteorological Magazine* of October 1949. The work forms part of the research programme of the Meteorological Office, and this note is published with the permission of the Director.

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Meteorological Office,
Air Ministry,
London, W.C.2.
Sept. 2.

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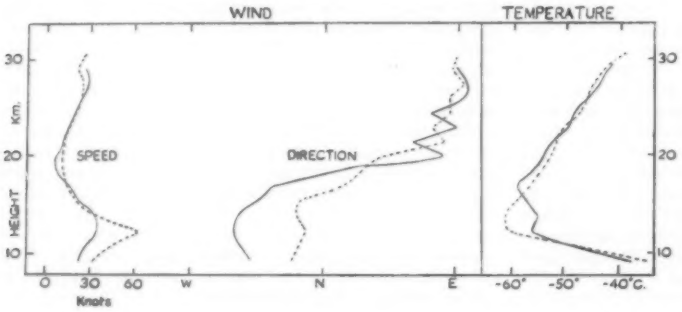
Crystal Size and Fluorescence Intensity

Anthracene crystals usually take the form of thin plates, and in ultra-violet light their fluorescence seems concentrated at the edges. This is because much of the fluorescence is unable to escape through the large flat surfaces, and undergoes numerous reflexions within the thin layer, emerging at the narrow faces. A part of the fluorescence light, therefore, travels very much farther through the material than it would if it could escape equally in all directions, and the effect of overlap of absorption and fluorescence bands is thereby greatly exaggerated. The shorter-wave side of the fluorescence band is weakened by re-absorption and energy degradation.

The effect was investigated by measuring the fluorescence band contours of anthracene with a high-aperture spectrograph having an electron multiplier at the exit slit. The readings were corrected for variations of the instrument sensitivity with wavelength by calibration against a tungsten band lamp of known temperature.

The accompanying table gives the measured intensities at the maxima of the vibrational band structure of the fluorescence band of anthracene, taking the 0–2 band as standard. Illumination by 3650 or by 2537 A. light gave identical results. Crystals of 1 mm. and 0·1 mm. diameter were obtained by sieving, those about 0·02 mm. by pouring a saturated solution in acetone into warm 15 per cent gelatine solution, 0·003 mm. by adding water to an acetone solution, and less than 0·0003 mm. by pouring an acetone solution into hot water. It will be seen that



Band	Crystals						Solutions in benzene		
	Wave-length (A.)	Approx. diameters (mm.) 1	0·1	0·02	0·003	0·0003	Wave-length (A.)	1 gm. per l.	0·1 gm. per l.
0–0	4050	7	7	16	16	23	3830	—	—
0–1	4250	103	133	162	161	180	4050	180	185
0–2	4450	100	100	100	100	100	4290	100	100
0–3	4750	27	20	25	27	24	4560	29	29

the intensity of the 0–1 band relative to the 0–2 increases as particle size diminishes, and approximates to the ratio for dilute solutions at the smallest particle size examined. Another effect was noticed in comparing similar particles spread on a dry flat surface or embedded in a thick gelatine layer. The spreading produces an orientation which is absent in the gelatine preparation. The greater randomness of the latter crystal positions causes an increase in the ratio of the 0–1 to the 0–2 band.

This effect of particle size and shape in forcing much of the emitted fluorescence light through long distances in the crystal compared with the very small penetration of the exciting light raises the question whether the apparent 'resonance transfer' effect observed in anthracene–naphthacene and similar systems[1] is not due to re-absorption of the primary anthracene fluorescence. To test this, a homogeneous solid solution of anthracene with 8×10^{-3} gm./gm. acridine was prepared by crystallizing about 15 per cent from a benzene solution of the components. In this solid the anthracene fluorescence is reduced to 0·66 of the value for pure anthracene. The absorption band of acridine is only a little to the long-wave side of that of anthracene; if the quenching effect is due to re-absorption of the anthracene fluorescence the 0-1 band should be much more reduced in intensity than the 0–2 band, whereas if the effect is due to resonance transfer the two bands should be equally reduced. No decrease in the 0–1 to 0–2 ratio was observed. Similarly, for anthracene containing naphthacene over the range $1{\cdot}8 \times 10^{-3}$ to $2{\cdot}5 \times 10^{-5}$ gm./gm., where the blue anthracene fluorescence is reduced in intensity, the ratio of the 0–1 to 0–2 bands was constant although somewhat higher than that of pure anthracene of the same apparent crystal size in the higher size range. This small difference is believed to be due to the lesser perfection of the solid solution crystals.

The results, therefore, favour the resonance transfer hypothesis for the effects of acridine and naphthacene on the fluorescence of crystalline anthracene.

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April 26.

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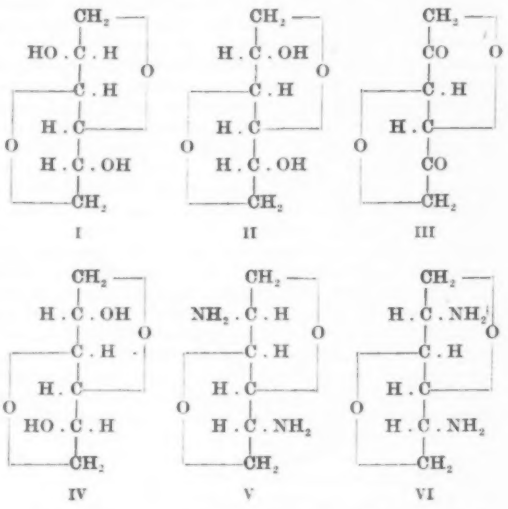
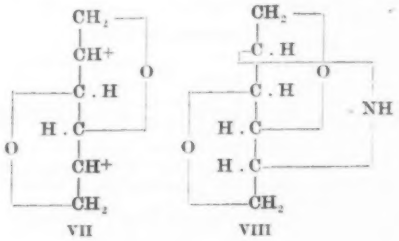
Interconversion of Dianhydro Hexitols and of Saccharic Acids

The conversion of 1 : 4-3 : 6-dianhydromannitol (I) and 1 : 4-3 : 6-dianhydrosorbitol (II) into the 1 : 4-3 : 6-dianhydride of L-iditol (IV) has previously been reported by Fletcher and Goepp[1], who effected the transformation by the dehydrogenation of either dianhydromannitol or dianhydrosorbitol with Raney nickel, followed by the hydrogenation of the intermediate, which is doubtless essentially the diketone (III). We have now effected the same transformation during studies on the deamination of amino-derivatives of sugar[2] and sugar alcohol derivatives.



2 : 5-Diamino dianhydromannitol (V) and 2 : 5-diamino dianhydrosorbitol (VI)[3] have each been treated with nitrous acid. Deamination proceeded smoothly, but the product in each case was 1 : 4-3 : 6-dianhydro-L-iditol (IV). Just as in the case of the hydrogenation of the diketone (III), any of the configurations L-iditol, D-mannitol or D-sorbitol is theoretically possible, so in this case, since the intermediate is doubtless the carbonium cation (VII), any of these three configurations may arise. That, in fact, the system takes on the L-iditol configuration both in this case and that recorded by Fletcher and Goepp indicates a certain configurational stability peculiar to L-iditol. This behaviour is paralleled by the ready epimerization of both 2 : 4-3 : 5-dimethylene-D-gluco- and -D-mannosaccharic acids to the corresponding derivative of L-idosaccharic acid[4]. Alternatively, the isolation of iditol or idosaccharic acid derivatives in the above instances, in which



three epimerically related substances are possible of formation, may be explained merely by the fact that the iditol or idosaccharic acid derivatives isolated may be more easily crystallizable or more insoluble than the isomeric materials.

This interconversion of dianhydro hexitols and also that of the saccharic acids is amenable to a theoretical interpretation on classical lines, whereas a mechanism for the conversion of mannitol and sorbitol into dulcitol recently described by Bladen, Owen, Overend and Wiggins[5] is difficult to envisage. In this case change of configuration occurred with sorbitol at C_4 and with mannitol at C_2 and C_4.

In an effort to determine whether, on deamination, 2 : 5-diamino 1 : 4-3 : 6-dianhydro-L-iditol would yield solely 1 : 4-3 : 6-dianhydro-L-iditol, attempts have been made to prepare this diamine. 2 : 5-Ditosyl 1 : 4-3 : 6-dianhydro-L-iditol was obtained and treated with methyl alcoholic ammonia under pressure in the manner found successful for the preparation of the diamines of dianhydro-mannitol and -sorbitol. No diamino derivative of dianhydro-L-iditol was obtained, however, and, instead, a secondary amine of m.p. 99–100° (found: C, 56·4; H, 6·9; N, 10·7; mol. wt. (Rast) 136. $C_6H_9O_3N$ requires C, 56·6; H, 7·0; N, 11·0; mol. wt. 127) was isolated. This, from the analytical data, appeared to be a compound possessing six carbon atoms and one nitrogen atom in the molecule. It formed a crystalline nitroso derivative and was characterized by the formation of well-defined salts. It was, therefore, 2 : 5-imino : 1 : 4-3 : 6-dianhydro 2 : 5-dideoxyhexitol. Since this has been derived from L-iditol, one would expect this configuration to be retained. Other evidence shows that the diamines derived from 2 : 5-ditosyl 1 : 4-3 : 6-dianhydro-mannitol and -sorbitol do, in fact, retain the configuration of the parent hexitols. Scale models show, however, that the imine derived from dianhydro L-iditol cannot possess the iditol configuration, and, in fact, that the only 1 : 4-3 : 6-dianhydro hexitol which can accommodate an imine bridge across C_2 and C_5 is dianhydro-D-mannitol. Such a contention involves Walden inversion at C_2 and C_5. This inversion is theoretically possible because the hydrolysis of a toluene-*p*-sulphonyl group does take place through the ionic scission of a carbon–oxygen bond, thus allowing the formation of an intermediate carbonium cation. We tentatively propose that the imine obtained by the ammonolysis of 2 : 5-ditosyl dianhydro-L-iditol is, in fact, 2 : 5-imino-1 : 4-3 : 6-dianhydro 2 : 5-dideoxy-D-mannitol (VIII).

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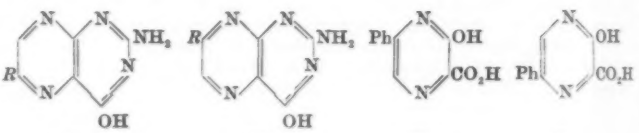
Application of Halogeno-Ketones to the Synthesis of Pteridines, including Pteroic Acid

Pteroic and pteroylglutamic acids were first synthesized from 2 : 4 : 5-triamino-6-hydroxypyrimidine (I), 1 : 2-dibromopropionaldehyde and *p*-aminobenzoic or *p*-aminobenzoylglutamic acids[1]. The action of an α-halogenocarbonyl compound on a 4 : 5-diaminopyrimidine introduces a new variation of the general method of pteridine synthesis remarkable for the spontaneous oxidation of the dihydropteridine initially obtained during the course of the reaction. It has been observed, however, that the formation of an intermediate dihydro derivative can sometimes be troublesome in that the hydrogen eliminated may effect the reduction of substituents[2]. The use of 1 : 1-dihalogeno-aldehyde or -ketone would, if successful, avoid this difficulty; but apart from Purrmann's somewhat analogous synthesis of xanthopterin from dichloracetic acid and the pyrimidine (I)[3], it is a modification not hitherto investigated.

We find that in marked contrast to the condensation of dichloracetic acid and the pyrimidine, which requires drastic conditions and gives xanthopterin in an over-all yield of only 6 per cent, 1 : 1-dichloracetone and 2 : 4 : 5-triamino-6-hydroxypyrimidine dihydrochloride buffered with sodium acetate in aqueous ethanol afford 53 per cent of 2-amino-6-hydroxy-8-methylpteridine at room temperature. The reaction between ω : ω-dichloroacetophenone and the pyrimidine occurred only slowly and heating was necessary, but again the yield of 2-amino-6-hydroxy-8-phenylpteridine was comparatively high (60 per cent).

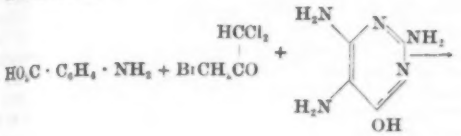


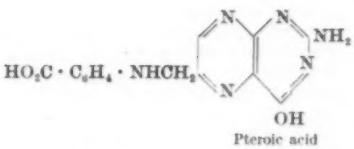
The orientation of the product as the 8-phenylpteridine (II; R = Ph) rather than the 9-phenyl-isomer (III; R = Ph) rests on the identification of the pteridine from 1 : 1-dichloroacetone as the 8-methyl derivative (II; R = Me), by oxidation to the 8-carboxylic acid[4]. Both (II; R = Me) and (II; R = Ph) differ from the products obtained from the pyrimidine (I) and methyl- and phenyl-glyoxal, which are, therefore, respectively the 9-methylpteridine (III; R = Me) (see Forrest and Walker[4]) and the 9-phenyl compound (III; R = Ph).

Both phenylpteridines have similar physical properties, but may be distinguished by degradation with 25 per cent aqueous sodium hydroxide at 170°. In this manner was obtained from the 9-phenyl compound (III; R = Ph) a mixture of 2-hydroxy-6-phenylpyrazine-3-carboxylic acid (IV), m.p. 208–209° (ethyl ester, m.p. 112°), with a small amount of the corresponding 2-amino-6-phenylpyrazine-3-carboxylic acid (decarboxylated in 80 per cent sulphuric acid at 200° to 2-amino-6-phenylpyrazine). On the other hand, alkali degradation of the 8-phenylpteridine (II; R = Ph) gave entirely 2-hydroxy-5-phenylpyrazine-3-carboxylic acid (V), m.p. 200° (ethyl ester, m.p. 158–159°).

The preparation of pteroic acid by this modified pteridine synthesis requires a 1 : 1 : 3-trihalogeno-

acetone, and a suitable derivative was obtained by the bromination of 1 : 1-dichloroacetone. The properties of the product (m.p. 31°, b.p. 92–93°/25 mm.) do not correspond with those given by Cloez[6] for 1 : 1-dichloro-3-bromoacetone, but a synthesis from dichloroacetyl bromide and diazomethane confirmed its structure.





Pteroic acid

The addition of an alcoholic solution of the ketone to one of the pyrimidine (I) and *p*-aminobenzoic acid in water buffered with sodium acetate gave a product which on microbiological assay showed 17 per cent pteroic acid activity, a value comparing very favourably with that recorded for the synthesis due to Waller *et al.*[1], in which 1 : 2-dibromopropionaldehyde was used.

The extension of these experiments to the preparation of other pyrazines, pteridines and related compounds will shortly be described in full.

Note added in proof (*September* 24). Since this account was communicated, Seeger, Cosulich, Smith and Hultquist [*J. Amer. Chem. Soc.*, **71**, 1753 (1949)] have briefly referred to the use of 1 : 1 : 3-tribromoacetone for syntheses in the pteroic acid series.

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P. C. Spensley
Dyson Perrins Laboratory, University of Oxford,
and University of Nottingham.
April 14.

[1] Waller *et al.*, *J. Amer. Chem. Soc.*, **70**, 19 (1948).
[2] Angier *et al.*, *J. Amer. Chem. Soc.*, **70**, 3029 (1948).
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[4] Angier *et al.*, *Science*, **103**, 667 (1946).
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[6] Cloez, *Ann. Chim. Phys.*, (6), **9**, 176 (1886).

Synthesis of the *Bz*-Chloro-indoles

In continuation of earlier work[1] on the inhibition of bacterial growth by substituted indoles and tryptophans, we have undertaken the synthesis, for ultimate biological investigation, of the four hitherto unknown *bz*-chloro-indoles and the derived tryptophans. The recent publication by Uhle[2] of a synthesis of 4-chloro-indole makes it desirable to put on record our own syntheses of the isomeric 5-, 6- and 7-chloro-indoles.

We prepared the 5- and 7-chloro-indoles by the standard Fischer cyclization of the *p*- and *o*-chlorophenylhydrazones of ethyl pyruvate, followed by hydrolysis and decarboxylation of the resulting chloro-indole-2-carboxylic acids. 6-Chloro-indole was prepared by oxidizing 2-nitro-4-chlorotoluene with chromic acid in acetic anhydride to the corresponding aldehyde diacetate[3], followed by condensation with nitromethane to 4-chloro-2 : β-dinitrostyrene and reduction[4].

The properties of the four *bz*-chloro-indoles are as follows :

	Melting point	Melting point of picrate
4-Chloro-indole*	Oil (b.p. 143°/10 mm.)	171–173°
5-Chloro-indole**	69–70°	148–148·5°
6-Chloro-indole**	89–90°	143–144°
7-Chloro-indole**	56–57°	156–158°

(* = Uhle[2]; ** = present work)

It is somewhat remarkable that the 4-compound is an oil, since the other isomers are all nicely crystalline solids.

We have converted the 5- and 7-chloro-indoles into 5-chloro-tryptophan, m.p. 278–279° (decomp.), and 7-chloro-tryptophan, m.p. 290–291° (decomp.), respectively, by the usual gramine synthesis[5]. 5-Chloro-tryptophan has also been obtained in good yield by the Fischer cyclization of the *p*-chlorophenylhydrazone of the Michael addition product from acetylaminomalonic ester and acrolein, followed by hydrolysis and decarboxylation[6]. We have in hand the synthesis of the 4- and 6-chloro-tryptophans and propose to extend our work to other substituted indoles and tryptophans, more especially the dichloro- and other halogenated derivatives. Full details of our work will be published elsewhere in due course.

Uhle implies in his paper that 4-substituted indoles have not previously been synthesized unambiguously, and claims that his synthetic procedure (condensation of 6-substituted-2-nitro-toluenes with ethyl oxalate followed by reductive cyclization of the resulting 6-substituted-2-nitro-phenyl pyruvic acid and decarboxylation of the 4-substituted-indole-2-carboxylic acid so produced) is new ; neither claim is justified. The synthetic method used by Uhle was introduced more than fifty years ago by Reissert[7] and has frequently been applied to the synthesis of substituted indoles, including those substituted in the 4-position (for example, the synthesis of 4-methoxy-indole by Blaikie and Perkin[8]) ; 4-substituted indoles have also been synthesized quite unambiguously by other methods, such as the cyclization[9] of the formyl derivatives of 6-substituted-2-amino-toluenes (for example, 4-methyl-indole[1,10]).

We wish to thank the directors of May and Baker, Ltd., for generous facilities placed at our disposal.

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April 14.

[1] Fildes and Rydon, *Brit. J. Exp. Path.*, **28**, 211 (1947). Rydon, *J. Chem. Soc.*, 705 (1948).
[2] Uhle, *J. Amer. Chem. Soc.*, **71**, 761 (1949).
[3] Cf. Barber and Stickings, *J. Chem. Soc.*, 168 (1945).
[4] Cf. Burton and Duffield, *J. Chem. Soc.*, 78 (1949).
[5] Albertson, Archer and Suter, *J. Amer. Chem. Soc.*, **67**, 36 (1945).
[6] Cf. Warner and Moe, *J. Amer. Chem. Soc.*, **70**, 2763, 2765 (1948).
[7] Reissert, *Ber. deutsch. chem. Ges.*, **30**, 1045 (1897).
[8] Blaikie and Perkin, *J. Chem. Soc.*, **125**, 296 (1924).
[9] Tyson, "Organic Syntheses", **23**, 43 (1943).
[10] Marion and Oldfield, *Canad. J. Res.*, **25B**, 1 (1947).

Hiptagenic Acid Identified as β-Nitropropionic Acid

Hiptagenic acid, $C_3H_5O_4N$, was originally isolated from the hydrolysate of hiptagin, a crystalline glycoside, m.p. 112° C., occurring in the bark of the tree, *Hiptage mandoblata*, by Gorter[1]. From a study of its properties the author ascribed to the acid the formula of a hydroxamic acid, namely, CHOH : COH.CO.NHOH. The acid was formed by the action of moderately concentrated hydrochloric acid on an acetone solution of hiptagen according to the equation :

$$\underset{\text{hiptagin}}{C_{16}H_{14}O_9N_2} + 3H_2O = \underset{\text{hiptagenic acid}}{C_3H_5O_4N} + CO_2 + NH_3 + \underset{\text{glucose}}{C_6H_{12}O_6}$$

The acid was later isolated from another crystalline glycoside, karakin, m.p. 122° C., extracted from the berries of the karaka tree, *Corynocarpus lævigata*, by Carrie[2], who identified his acid by a mixed melting point with a specimen of Gorter's acid.

Later work by Carter[3] showed that the two glycosides have identical composition and properties apart from different melting points and optical rotation, and appear to be stereoisomeric forms of the formula $C_{16}H_{14}O_9N_2.\frac{1}{2}H_2O$.

When karakin is boiled in aqueous solution for six hours or more, it is almost completely hydrolysed to hiptagenic acid and an amino-sugar which loses carbon dioxide according to the equations:

(*a*) $C_{16}H_{14}O_9N_2 + 2H_2O = C_3H_5O_4N + C_7H_{13}O_7N$
(*b*) $C_7H_{12}O_7N = C_6H_{11}O_5NH_2 + CO_2$.

Recently, Carter and McChesney, from a consideration of the properties of β-nitropropionic acid, and bearing in mind the fact that Gorter had obtained a small yield of sodium nitrite from hiptagenic acid by the action of sodium ethylate, prepared some of the former acid from β-iodopropionic acid and silver nitrite. The synthetic acid gave no depression of the melting point when mixed with hiptagenic acid, and proved to be in other respects identical with the acid obtained from natural sources.

Hiptagenic acid is probably the first organic nitro-compound to be isolated from plants, and it is also probable that the nitro group is present in the hiptagin and karakin molecules, since a comparison of the ultra-violet absorption spectra of hiptagenic acid and of karakin shows the same characteristics.

C. L. Carter
W. J. McChesney

Department of Chemistry,
University of Otago. April 5.

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A New Method for Forming Vinyl Polymers in Wool

When ethylene sulphide is polymerized from the vapour phase in wool[1], reduction of the cystine is considered to occur[2], the cysteine side-chains so produced then taking part in polymerization as follows:

$$\underset{\text{reduced wool}}{-CH_2\cdot SH} + n\ \begin{matrix} CH_2 \\ | \\ CH_2 \end{matrix}\!\!>\!S \longrightarrow -CH_2\cdot S(CH_2\cdot CH_2\cdot S)_{n-1}\cdot CH_2\cdot CH_2\cdot SH.$$

In support of this, Blackburn and Phillips (*loc. cit.*) found that more polymerization occurs if the cystine in the wool is previously reduced with thiolacetic acid, although sodium bisulphite was ineffective.

These findings have now been extended to the polymerization of vinyl compounds in wool, using aqueous solutions. With such systems, it is usual to introduce some external form of initiator, such as iron (Fe^{++}) and hydrogen peroxide[3,4]; but it has now been found that the wool can provide its own catalyst in the form of reduced cystine.

A conditioned sample (2·5 gm.) of purified all-wool flannel was immersed in 30 c.c. of a 10 per cent solution of thiolacetic acid for 3 hours at 30° C. A second sample was placed in 50 c.c. of a 2 per cent solution of sodium bisulphite, raised to the boil in five minutes and boiled for three minutes; a third sample was similarly treated with a 2 per cent solution of sodium hydrosulphite. After treatment, each was washed in running water and then immersed in 50 c.c. of a 4 per cent solution of methacrylic acid for sixteen hours at 22° C. After washing for eight hours in running water, the samples were conditioned and weighed. Increases in weight due to polymer deposition were as follows: (i) pretreated with thiolacetic acid, 14·5 per cent; (ii) pretreated with sodium bisulphite, 10·7 per cent; (iii) pretreated with sodium hydrosulphite, 3·1 per cent.

Wool without pretreatment did not show any significant increase in weight. Pretreatments with thiolacetic acid and sodium bisulphite are each very effective in promoting polymerization, and the general mechanism is probably similar to that postulated for ethylene sulphide, the polymer being chemically bound as follows:

$$\underset{\text{reduced wool}}{-CH_2\cdot SH} + n\ CH_2 = \underset{\text{monomer}}{\overset{R}{\overset{|}{CH}}} \longrightarrow -CH_2\cdot S\cdot(CH_2\cdot\overset{R}{\overset{|}{C}}H)_{n-1}\cdot CH_2\cdot CH_2\cdot R.$$

M. Lipson

Council for Scientific and Industrial Research,
Wool Textile Research Section,
Geelong, Australia. April 11.

[1] Barr and Speakman, *J. Soc. Dyers and Colourists*, **60**, 238 (1944).
[2] Blackburn and Phillips, *J. Soc. Dyers and Colourists*, **61**, 203 (1945).
[3] Lipson and Speakman, *Nature*, **157**, 590 (1946).
[4] Lipson and Speakman, *Nature*, **157**, 736 (1946).

A New Method of Peptide Synthesis

It has been observed previously that an acylphosphate, the phosphoric group of which is bound in an ester linkage, reacts readily at 37° in aqueous solution of *p*H 7·4 with the amino-group of a free amino-acid, forming the corresponding acylated amino-acid[1].

The same reaction can be applied to the synthesis of true peptides.

Phenyl carbobenzoxyglycyl phosphate

$$C_6H_5\cdot CH_2\cdot O\cdot CO\cdot NH\cdot CH_2\cdot CO\cdot O\cdot P\begin{matrix} OH \\ \\ O\cdot C_6H_5 \end{matrix}\!\!=O$$

has been prepared by the reaction of carbobenzoxyglycyl chloride with disilver phenylphosphate. Phenyl carbobenzoxyglycylphosphate reacts very rapidly with amino-acids, forming the corresponding carbobenzoxyglycylpeptides, from which the free peptides can be obtained by catalytic hydrogenation.

Up to the present, glycylglycine, glycyltryptophane and glycylglycyltryptophane have been prepared in this way.

A remarkable feature of this new method is that it permits the synthesis of oligopeptides without isolation of the intermediary products (dipeptide, tripeptide, . . .) by alternately adding the phenyl carbobenzoxyaminoacylphosphate and hydrogenating the resulting carbobenzoxypeptide. All the operations are carried out in aqueous solution at 37° and *p*H 7·4; the yields are high, even in *M*/100 concentration of both reacting substances.

From the biochemical point of view, the formation of true peptides in a reaction involving an amino-acylphosphate derivative provides a model of peptide synthesis, the interest of which is due to the fact that acylphosphates are believed to play an important part in peptide-bond formation within the living cell[2-5]. It is also noteworthy that this reaction takes place under physiological conditions of *p*H, temperature and concentrations.

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April 12.

[1] Chantrenne, H., *Biochem. et Biophys. Acta*, **2**, 286 (1948).
[2] Lipmann, F., *J. Biol. Chem.*, **160**, 173 (1945).
[3] Cohen, P. P., and McGilvery, R., *J. Biol. Chem.*, **166**, 261 (1946); **169**, 119 (1947); **171**, 121 (1947).
[4] Speck, J., *J. Biol. Chem.*, **168**, 403 (1947).
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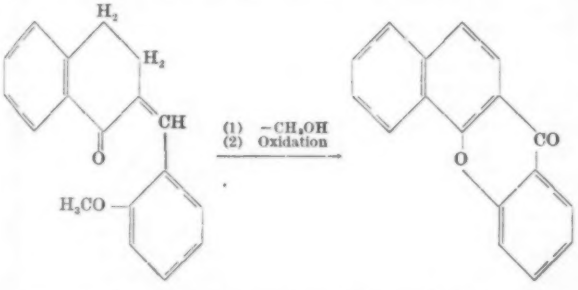
Further Studies on 3 : 4-Benzxanthenes

3 : 4-BENZXANTHENE was first prepared by Baddar and Gindy, who oxidized it quantitatively and easily to the corresponding ketone[1]. 3 : 4-Benzxanthone, however, has been prepared directly, although in poor yields, by Graebe and Feer[2], von Kostanecki[3], and Knapp[4].

On account of the ease with which 3 : 4-benzxanthene is oxidized to 3 : 4-benzxanthone, it was thought that by carrying out the cyclization under more drastic conditions, oxidation might also be effected. Therefore, a strongly heated mixture of fused potassium hydrogen sulphate and anhydrous sodium sulphate was used to effect the cyclization of 2-(*o*-methoxybenzylidene)-α-tetralone instead of the fused mixture of anhydrous potassium hydrogen sulphate and anhydrous sodium sulphate originally used[1]. Under these new conditions, the potassium hydrogen sulphate was completely transformed to the pyrosulphate, which will act as a cyclizing as well as an oxidizing agent. The reaction was then carried out as before; the product separated out from alcohol in lemon-yellow needles, m.p. 147–149°; raised on admixture with an authentic 3 : 4-benzxanthone specimen to 155–158°. This indicated that the product was an impure sample of 3 : 4-benzxanthone.



Many fruitless attempts were made to purify the above sample, by distillation in vacuum, sublimation under reduced pressure, or repeated crystallization (up to eight times) from either alcohol, methyl alcohol, acetic acid or their dilute aqueous solutions, benzene, benzine, chloroform or dioxan. It was only slightly decolorized on heating with freshly activated animal charcoal for fifteen minutes, followed by crystallization, although the melting point was very slightly raised. A dilute solution of the yellowish product in benzene or methyl alcohol was passed through an alumina adsorption column 20 cm. long.

All attempts to purify the substance were unsuccessful. The best results were obtained by treatment with dilute potassium permanganate in aqueous acetone (at room temperature or hot), when most probably its complete oxidation was effected.

This showed, beyond doubt, that the presence of a pyrosulphate radical in the cyclizing mixture influences the oxidation of the molecule to the 3 : 4-benzxanthone. This oxidation is, however, partial; and might be related to the amount of the pyrosulphate present, a fact that accounts for the relatively low yields of the 3 : 4-benzxanthene formerly produced.

The yield of cyclization of 2-(*o*-methoxybenzylidene)-α-tetralone was improved by stirring it with a well-powdered mixture of fused potassium hydrogen sulphate and anhydrous sodium sulphate at 230–235° instead of 260–270° (hence no pyrosulphate is present), then proceeding with the reaction as indicated before (cf. Baddar and Gindy[1]).

Attempts are now being made to prepare substituted 3 : 4-benzxanthenes and dibenzxanthenes and their oxidation products according to the new modification of the reaction.

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[2] Graebe, C., and Feer, A., *Ber.*, **19**, 2612 (1886).
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Distinction of Vermiculite, Chlorite and Montmorillonite in Clays

THE frequency with which vermiculitic and chloritic minerals as well as montmorillonites probably occur in soil-clays makes it necessary to have a clear-cut method for distinguishing them. The similarity of their X-ray powder diffraction patterns renders certain identification practically impossible without some prior treatment of the clay, especially if more than one of them is present in a given sample. Identification can, however, be made relatively easy by observing the variation in the position of the strong basal line, which normally occurs at about 14 A. on the diffraction patterns of all three minerals, after various treatments.

Montmorillonite is most simply identified by means of the well-known glycerol technique, in which the first-order basal line is displaced to 17·7 A.[1]; and the persistence of a 14 A. line after this treatment indicates vermiculite or chlorite or both. Heating at 500° C. for a number of hours, followed by immediate sealing of the sample (to prevent rehydration) into a glass tube in which it can be photographed, causes the (001) line of montmorillonite to shift to 9–10 A., and the 14 A. vermiculite line behaves similarly. The persistence of a 14 A. line after this treatment is therefore strongly indicative of chlorite. Vermiculite can be positively identified by leaching with a solution of an ammonium salt, which causes

the displacement of the 14 A. line to about 11 A.[2] even if glycerol is afterwards added to the sample.

A combined three-way test which I have found useful consists in leaching with ammonium salt solution (or boiling gently for a few minutes), adding glycerol to the washed and dried residue, and photographing. Lines at about 11 A., 14 A. and 17·7 A. indicate vermiculite, chlorite and montmorillonite respectively; although, in the event of chlorite being indicated by this test, it is always advisable to check the identification by heat-treatment. If more than one of the minerals are present, some idea of their relative abundance can be gauged from a comparison of the appropriate line intensities.

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April 25.

[1] MacEwan, D. M. C., *Nature*, **154**, 577 (1944); *J. Soc. Chem. Indust.*, **65**, 298 (1946).
[2] Walker, G. F., [*Nature*, **163**, 762 (1949)].

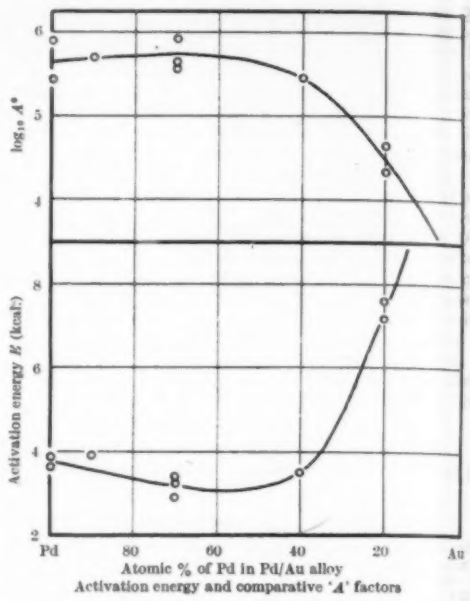
Parahydrogen Catalysis by Transition Metals

WE have made experiments to test the hypothesis put forward in a recent review article[1] that the activation of hydrogen gas by the transition metals is connected with the presence of unpaired *d*-electrons or holes in the electronic *d*-band of the metal.

In the first place, we have examined the catalytic activity of palladium–gold alloys for the para-hydrogen conversion (here due to the chemical, not the paramagnetic mechanism[2]). The similarity of atomic radii of palladium and gold suggests that neither component will tend to be adsorbed at the alloy surface, and that changes in lattice spacing will be small. These two metals form a complete range of homogeneous solid solutions, and they were examined in the form of wires under good high-vacuum conditions (cf. Eley and Rideal[3]). The surfaces were freed from adsorbed oxygen by treatment with atomic hydrogen at −183° C., since the low melting point of the alloys precluded outgassing at very high temperatures. We express our results as activation energy E and frequency factor A°, in the expression for the first-order constant, $k = A^\circ \exp(-E/RT)$. A° refers to the standard volume of 1 c.c. and catalyst area[3] of 1 cm.[2]. The pressure used was 1·2 mm. The accompanying graph shows how E and A° scarcely change from pure palladium up to 40 atomic per cent palladium, when an abrupt *increase* in E and *decrease* in A° occurs. Gold is so poor a catalyst that we have so far been unable to determine a value of E for it.

Secondly, we have found that the high catalytic activity of pure palladium falls almost to zero when the wire is saturated with *dissolved* hydrogen atoms, produced *in situ* by the action of an electrodeless discharge, with the wire at 20° C. Again, changes in lattice spacing are small.

To explain these results we invoke the theory of Mott and Jones[4] for the magnetic susceptibility of palladium alloys, which postulates that the added gold or hydrogen atom passes its electron into the *d*-band of the palladium, because of the high density of energy levels in this band, compared with the overlapping *s*-band. The magnetic results suggest about 0·6 holes in the *d*-band of palladium, so that the critical gold concentration above corresponds roughly to the complete filling of the *d*-band. Up to this concentration



Activation energy and comparative 'A' factors

of gold, we conclude that vacant surface *d*-orbitals are present and that these give rise to the low activation energy, rather than any lattice-spacing or other effect. The parahydrogen conversion on tungsten[5,6], nickel and probably platinum and palladium[6] involves an exchange of hydrogen atoms between a chemisorbed hydrogen atom, symbolized M—H, and a molecule of hydrogen held adjacent to it in a van der Waals layer. The exact nature of the transition complex is still not certain; but it may well involve three hydrogen atoms bound to the metal M.

$$M\text{—H} + p\mathrm{H_2} \rightarrow o\mathrm{H_2} + M\cdot\mathrm{H}$$

$$\begin{matrix} & \times & \times & \times \\ & \mathrm{H} & \mathrm{H} & \mathrm{H} \\ \times M & & & M\times \end{matrix}$$

Possible transition complex.

The crosses indicate electrons, mobile in the sense of molecular orbital theory. The activation energy E denotes the *difference* in energy between initial and transition states. In a general way, one can say that a metal *d* orbital would be expected to give a stronger bond to a hydrogen atom than an *s* orbital because of (*a*) its lower energy, (*b*) a possible greater overlapping with the *s* electron of the H atom. This explains why transition metals give a strong chemisorption of hydrogen. The small negative charge on chemisorbed hydrogen (dipole W^+H^-, moment 0·4 *D*)[7] would fit in well with the idea that a 'projecting' *d* orbital is used. If a second similar bond to the metal is formed, in the transition state, one can appreciate again that a low activation energy will result. We do not wish, however, to stress particular mechanisms at present.

The *decrease* in A° with increase in E is most striking, although many cases are known where A° and E *increase* together. On transition state theory[8], $A^\circ = \text{const.} \frac{kTf_\ddagger}{hf_i}$, where $f_\ddagger(f_1)$ are the partition-functions of the transition (initial states). If we admit some mechanism such as that above, then $f_\ddagger/f_i$ will

be greatest for the *d* rather than the *s* metal orbitals, because the higher density of states of the former will lead to a higher electronic weight term in the ratio f_π/f_i. Dowden[9] has recently suggested that the density of states in a metal may determine the *A* factor; but his suggestion that the hydrogen bond is ionic in the sense M^-H^+ disagrees with reliable contact potential data[7] and energy calculations[10]. In our opinion, the bond is essentially covalent, the ionization potential of hydrogen being too high to admit the other view.

At a later date we shall present these and other results in full, and discuss examples in the literature of poisoning of transition metal that may be ascribed to *solution* of hydrogen atoms in the metal. Similarly, activation procedures such as anodic oxidation may be attributed to *removal* of such dissolved atoms. In the meantime, we would direct attention to the possible implications of our work for studies on hydrogenation and hydrogen overvoltage.

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University, Bristol.
March 10.

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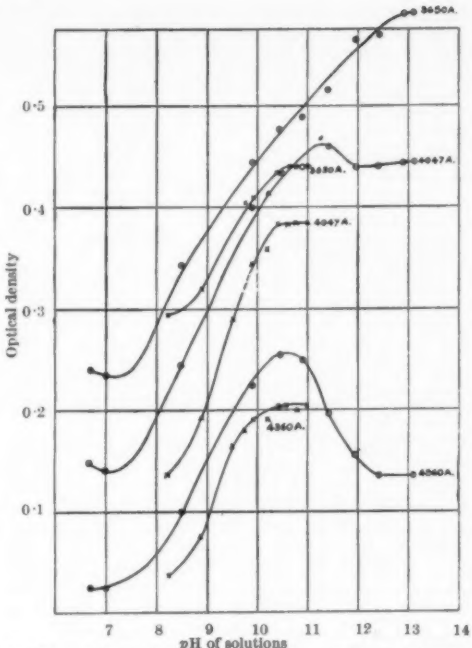
Absorptiometric Determination of Uranium

The communication by T. R. Scott[1] raises the point of the effect of bicarbonate in the hydrogen peroxide method for the absorptiometric determination of uranium. It should be pointed out that although this particular example had not been noted previously, it is one instance of two general effects which have not been stressed in the literature referring to this method. These are that the light absorption or optical density for a given concentration of uranium with excess peroxide present is dependent (*a*) upon the final *p*H and (*b*) upon the particular alkali used (or if a mixture, upon the relative amounts); for example, we have shown that sodium hydroxide and sodium carbonate may give different results even at a given final *p*H. The accompanying graph illustrates these points.

It can also be seen from the graph that at 365 mμ the sensitivity of the method is some 25 per cent greater at the higher *p*H values than at the *p*H of approximately 11 reached by Sandell's[2] conditions as used by Scott[1].

Optical density of solutions containing 1 mgm. uranium, 0·5 ml. 20 vol. hydrogen peroxide, 1 gm. sodium bicarbonate and various amounts of other alkali in total volume of 50 ml.

Other alkali added	*p*H value of final solution	Optical density (4-cm. cell) 365 mμ	405 mμ
Nil	9·1	0·282	0·254
10 ml. 10% NaOH	12·95	0·568	0·403
5 ml. 10% Na_2CO_3 + 10 ml. 10% NaOH	12·9	0·565	0·395
5 ml. 10% Na_2CO_3 + 5 ml. 10% NaOH	12·4	0·525	0·400



○—○—, Sodium hydroxide; ×—×—, sodium carbonate

Influence of *p*H on optical density. Solutions represented contain 1 mgm. uranium in a total volume of 50 ml. and are measured on the Spekker using the mercury lamp and 4-cm. cell

This sensitivity was achieved with a commercial filter absorptiometer using a mercury lamp source, although the details of the graph have also been checked spectrophotometrically.

It is possible to overcome the effect noted by Scott, for reasonable amounts of sodium bicarbonate, or carbonate, or both, by addition of sodium hydroxide to a *p*H of 12·9, as the accompanying table shows. It is hoped that a fuller account of the work mentioned here will be published elsewhere.

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Pyrophosphatase Activity of Brain Tissue

An enzyme capable of hydrolysing inorganic pyrophosphate was demonstrated in muscle by Lohmann[1]. It has also been found in various other tissues[2–4] and organisms[5,6], and its properties have been examined in detail in preparations obtainable from yeast[7] and from erythrocytes[8]. The system does not, however, appear to have been demonstrated previously in brain tissue; accordingly, it may be of interest to quote some experiments on the magnesium-activated pyrophosphatase activity of rat brain, carried out here as part of a more comprehensive investigation of brain phosphatases.

Phosphatase-containing preparations, in the form of dry powders, were made from fresh whole rat brains by a method previously described[9], and were made up into suitable suspensions when required for use. Pyrophosphatase activity was measured at 37° C. and at various *p*H values (using acetate and veronal buffer solutions), the incubation period in each case being half an hour, and the orthophosphoric acid liberated was finally estimated on aliquots of the trichloracetic acid-treated filtrates by the method of Fiske and Subbarow[10]. Results are expressed in millimoles substrate decomposed in half an hour per 100 gm. original tissue.

Preliminary experiments showed that the substrate concentration optimum is of the order of 0·0005 *M*, and the *p*H optimum in the region of 6·8–7·4. In absence of magnesium ions, the enzyme is practically inactive, but is activated optimally by 0·02 *M* magnesium chloride. Activity is destroyed completely by heating the preparation for half an hour in a boiling-water bath.

The accompanying table gives typical results showing the optimum pyrophosphatase activity of the preparations, compared with the 'acid' and 'alkaline' phosphatase (*p*H optima 5·0 and 9·4) activity of the same preparations measured under the optimum conditions appropriate for these enzymes[11] with sodium α-glycerophosphate as substrate. Observations illustrating the effects on the pyrophosphatase of various substances which are known to inhibit the yeast and erythrocyte enzymes are included.

Enzyme	Concentration of inhibitor	Activity (m*M* substrate decomposed/ hr./100 gm. tissue)	Inhibition (per cent)
Acid phosphatase	—	0·33	
Alkaline phosphatase	—	1·30	
Pyrophosphatase	—	7·26	—
,,	0·002 *M* $CaCl_2$	0·80	89·0
,,	0·00002 *M* $CuSO_4$	0·91	87·4
,,	0·02 *M* alloxan	0·42	94·4
,,	0·02 *M* sodium iodoacetate	1·66	77·2

The inhibitory effects noted in the table, together with other factors governing the activity of the pyrophosphatase, point to a definite similarity with the erythrocyte enzyme, and to the probability that the brain enzyme, as well as the erythrocyte one, contains active thiol groups within its structure. The strong activity of pyrophosphatase in the brain preparations, relative to that of the acid and alkaline phosphatases, may indicate that it plays an important part in the phosphorus metabolism of the brain. Interesting information in this connexion may be revealed by further study of the system.

I acknowledge my indebtedness to Mr. R. J. Everson for technical assistance.

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Endogenous Formation of Carbon Monoxide in Man

When determining the carboxyhæmoglobin concentration by analysing the concentration of carbon monoxide in the alveolar air according to a method described earlier[1], it has been observed that a low concentration of carbon monoxide is present invariably in the alveolar air in man. To investigate this observation, it was necessary (1) to determine whether it really is carbon monoxide that gives the effect with the indicator used, and (2) to endeavour to show whether the presence of *this factor* in the alveolar air is due to carbon monoxide absorbed from the atmospheric air or to endogenous formation.

Three different methods were used for the determination of carbon monoxide in air. With the indicator used, carbon monoxide is oxidized by a metallic oxide mixture ('Hopcalite') at room temperature, and the heat effect is measured on a differential thermometer. In the second method the combustion effect of 'Hopcalite' at room temperature was used, and the consequent production of carbon dioxide was estimated by absorbing it in barium hydroxide solution or ascarite. The third method used was the iodine pentoxide method[2]. All three methods gave the same results within the errors of measurement with alveolar air samples from different test persons.

The second question, namely, whether the presence of carbon monoxide is due to absorption from the atmosphere or to endogenous formation, was examined in the following manner. Carbon monoxide determinations were carried out both previous to and after five hours respiration through a filter completely absorbing the carbon monoxide. No decrease could be observed in the alveolar carbon monoxide concentration; on the contrary, there was rather an increase. It also became clear that carbon monoxide is constantly being emitted from the lungs, for small quantities of carbon monoxide (0·00013 — 17 per cent) over and above the possible percentage of carbon monoxide in the inhaled air were constantly found in the expiratory air on different test persons during normal breathing of atmospheric air. Estimations of the amount of carbon monoxide exhaled during 2½–3 hours was also made by collecting the expiratory air in bags during repeated 30-minute periods. From these determinations it was calculated that for three different test persons, 0·5, 0·65 and 1·05 c.c. respectively of carbon monoxide was exhaled per hour, with little or no change of the concentration of carboxyhæmoglobin.

The carbon monoxide concentration in the alveolar air remains roughly constant in one and the same individual in normal circumstances. Tests of three individuals with oxygen gave the mean values of 0·0021 ± 0·00014, 0·0024 ± 0·00011 and 0·0022 ± 0·00008 for 15, 15 and 32 determinations respectively.

As will be seen from the accompanying table, when comparisons are made between different normal individuals who do not smoke or who may not be

Carbon monoxide concentration in the alveolar air in tests taken with 100 per cent oxygen, and its relation to sex, body-weight, body-surface and the total quantity of hæmoglobin

Material	Number	Carbon monoxide concentration × 10,000	Correlations with body-weight	Correlations with body-surface	Correlations with total hæmoglobin
Children	57	23·5 ± 0·9	+ 0·64	+ 0·59	+ 0·53
Women	36	20·2 ± 0·7	+ 0·27	+ 0·24	+ 0·46
Men	46	22·0 ± 0·5	+ 0·39	+ 0·36	+ 0·49

expected to absorb carbon monoxide from the atmospheric air, fairly similar concentrations are found. The table also illustrates that the carbon monoxide concentration in the alveolar air in the case of children shows a correlation with the body-weight; but in adults there seems to be a correlation with the quantity of hæmoglobin in the body.

The presence of this alveolar carbon monoxide has been studied in a number of diseases, and it has been found that it may undergo considerable changes. It is increased in the following pathological states: polycythæmia, some cases of pernicious anæmia during specific treatment, anæmia with signs of blood decomposition, such as hæmolytic anæmias, some cases of aplastic anæmia, after blood transfusions, vein thrombosis both spontaneous and artificially developed, and hæmolysis in connexion with surgical operations. The presence of carbon monoxide in the alveolar air, on the other hand, was not increased *inter alia* in cases of secondary anæmia which have not been treated with blood transfusions, in diseases of the heart, hypertension, diabetes mellitus and morbus basedowi and cancers of different localization. The highest concentrations have been found in the hæmolytic anæmias, when concentrations up to seven times the normal have been measured. When the diseases have abated, the carbon monoxide values have also become normal.

The observations so far made seem to show that small quantities of carbon monoxide are constantly being formed in the human body and are emitted with the expiratory air; this endogenous carbon monoxide formation increases considerably in certain pathological conditions with abnormal decomposition of the blood cells.

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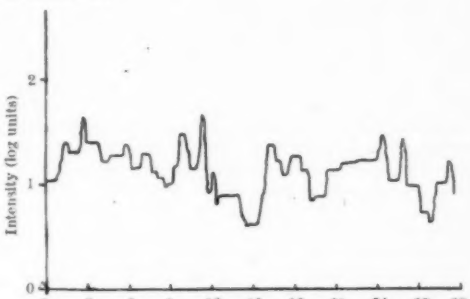
Continuous Recording of Sensory Thresholds and Other Psycho-Physical Variables

THE following method of recording continuously a sensory threshold or other psycho-physical variable may, it is thought, be capable of a wide variety of applications to psycho-physiological problems. The intensity of a stimulus is made to increase automatically at a constant rate from a point below the threshold value. When the subject perceives the stimulus, he presses a button, and keeps it depressed for so long as the stimulus is perceptible. The depression of the button is made to reverse the stimulus-control mechanism so that the intensity now decreases automatically at the same constant rate as it before increased. When the subject no longer perceives the stimulus he releases the button, the stimulus control is again reversed, and the cycle of events repeats itself. The system is thus a cyclic one with intermittent control exercised by the human operator, and the stimulus control hunts about the threshold value.

The position of the control may be recorded on moving paper, and a record of changes in the threshold obtained. There may, however, be a large indifference-range, and for many purposes it is convenient to eliminate this from the record by deliberately introducing an amount of backlash in the recording system approximately equal to the indifference-range. The system then responds only to changes in operating level of the control mechanism, and is unaffected by the individual excursions. If the backlash is precisely equal to the indifference-range, no loss of sensitivity results. The indifference-range is found to be reasonably constant in any given subject.

In one application of the method, at present in use for recording the absolute intensity threshold for central vision, the intensity of the stimulus is controlled by the movements of a neutral-wedge filter. A rate of change of intensity of about 0·5 log units per second is found convenient, and the indifference-range is of the order of 1 log unit. Since the time taken for reversal on pressing or releasing the button is negligible, a complete cycle of operation occupies about four seconds. This rate of operation can be comfortably maintained by the subjects for periods of at least half an hour, and changes in the threshold in time are, thus, closely followed in the record. The accompanying figure shows the type of record obtained, and it will be seen that the threshold, as measured by this method, shows considerable fluctuations, the period of which may extend to five minutes. (In this record, the indifference-range of the subject was consistently a little smaller than the backlash introduced, resulting in some 'squaring-off' of the fluctuations.)



Backlash, 1 log unit

The advantages claimed for this method are: (1) the fact that it provides a nearly continuous record; (2) the simplicity and the standard character of the subject's task, which amounts to a simple adjustive skill; and (3) the wide range of possible applications to problems both of peripheral and of central mechanisms.

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Anisotropic Permanent Magnet Alloys

MEASUREMENTS of some magnetic characteristics of an anisotropic permanent magnet alloy have recently been made by Jellinghaus[1]. From the results, certain conclusions about domain magnetization in such alloys were drawn.

For some time, we have been engaged in similar work on the anisotropic permanent magnet alloy, 'Alcomax'. The results of our measurements (see table) confirm some of the conclusions arrived at by Jellinghaus and carry them a stage further, besides giving information about the origin of the remarkable magnetic hardness of this type of alloy.

	Isotropic sample (hardened without field)		Anisotropic sample (hardened in field)			
			Hardened		Fully treated	
	Hardened	Fully treated	∥ p.d.	⊥ p.d.	∥ p.d.	⊥ p.d.
χ_i (initial susceptibility)	1·0	0·35	0·093	1·10	0·076	0·45
χ_r (reversible susceptibility at remanence)	0·46	0·35	0·08	1·05	0·12	0·49
J_r/J_s (ratio of remanent to saturation magnetization)	0·76	0·61	0·93	0·24	0·875	0·36
H_c (coercive force)	233	510	245	135	585	350
b (constant of formula $J = J_s\left(1 - \frac{b}{H^2}\right)$ for H = 1,000–1,500 oersted)	$4·7 \times 10^4$	$1·43 \times 10^5$	$2·6 \times 10^4$	$1·26 \times 10^5$	$5·1 \times 10^4$	$2·7 \times 10^5$
J_s (saturation magnetization)	1110	1075				

It is known that these alloys are body-centred cubic[2] and specimens have been cast with columnar crystals (that is, in which all the crystals have one axis parallel to a given direction). Such samples possess much improved magnetic properties, and have been subjected to a detailed examination by magnetostriction measurements[3], the results of which can be explained if the cube edge is the preferred direction of domain magnetization and the common crystal axis. If the alloy is cooled in a magnetic field, it becomes anisotropic, showing a higher remanence and coercive force in the direction in which the field was applied during cooling (preferred direction, p.d.) than in a perpendicular direction.

All the observed results can be explained if it is assumed that the magnetization energy has a cubic symmetry with an anisotropy constant $K_1' > 0$ (that is, the easy direction coincides with a cube edge). This symmetry may be due either mainly to magneto-crystalline energy or mainly to the demagnetization energy of heterogeneous aggregates of cubic symmetry (such as, for example, octahedrons) of sufficiently small size to form single domains[4]. When the alloy is cooled in a magnetic field, this cubic symmetry is disturbed by superposition of a uniaxial term (anisotropy constant K_2') with its easy axis in the preferred direction.

The postulated heterogeneity in composition is suggested by the saturation-intensity/temperature curves and measurements of the approach to saturation in fields of 2,000–5,000 oersted. Néel's[5] ideas applied to these last-mentioned measurements result in a root mean square value of the spontaneous magnetization of $\overline{J_s} = 1·10\ J_s$ in the hardened sample, and $\overline{J_s} = 1·17\ J_s$ in the hardened and tempered (fully treated) sample.

Measurements of the approach to saturation in fields of 1,000–1,500 oersted and of the reversible energy of magnetization allow an estimate of K_1' giving a value of approximately $1·25 \times 10^6$ ergs/cm.^{3} for the hardened and 2×10^6 ergs/cm.^{3} for the fully treated sample. If these values of the quasi-crystal anisotropy constant and the values of $\overline{J_s}$ are inserted in the formulæ given by Néel[6], the coercive force comes out as 200 oersteds and 450 oersteds respectively. The corresponding experimental values are 233 oersteds and 510 oersteds. We suggest that by using the observed quasi-crystal anisotropy instead of the true magneto-crystalline anisotropy, which, for an alloy of this type, is immeasurable, we introduce into Néel's theory the influence of shape anisotropy which has been dealt with at length by Stoner and Wohlfarth[4], and has been mentioned elsewhere by Néel[7].

For the anisotropic sample the postulated energy distribution predicts values of the measured magnitude for all properties if K_2' is assumed to be rather smaller than K_1'. The value of $(J_r/J_s)_{\parallel \text{ p.d.}} = 0·93$ is greater, and that of $(J_r/J_s)_{\perp \text{ p.d.}} = 0·24$ smaller than that calculated for cubic anisotropy only[8]. These results are due to the magnetic vector at remanence being drawn slightly out of the direction of the cube axis into the preferred direction owing to the superposed uniaxial anisotropy.

The difference between $\chi_{i\parallel \text{ p.d.}}$ and $\chi_{i\perp \text{ p.d.}}$ is slightly greater than would be expected on the basis of rotation of domain magnetization alone. Our model allows us to suppose that a few 90° boundary movements can occur and thus also explain the difference between χ_i and χ_r in the isotropic sample.

The empirical constant b is a measure of the ease of approach to saturation; the larger it is, the greater the field required to produce a given degree of saturation. Our model will certainly predict a small value of b in the preferred direction and a large value perpendicular to it, in agreement with experiment.

Two explanations for the uniaxial energy term responsible for the anisotropy can be given, magnetostrictive stress and shape anisotropy of domains respectively. Measurements[3] allow us to put the magnetostriction constant λ at the most at 4×10^{-5}, and Young's modulus at $2·5 \times 10^{12}$ dynes/cm.^{2}, giving the maximum magnetostrictive stresses as 10^8 dynes/cm.^{2}. The hysteresis curve of 'Alcomax' is scarcely altered by a longitudinal pressure seven times greater than this, which appears to exclude the stress theory. The shape anisotropy energy of Stoner and Wohlfarth[4] is thus left as the most likely explanation of the uniaxial energy term. Although tempering increases the coercive force, it reduces the difference in magnetic characteristics parallel and perpendicular to the preferred direction. This result would be expected as a consequence of an isotropic increase in the heterogeneity.

The model of the mechanism producing the properties of anisotropic permanent magnet alloys put forward may not be the only one capable of explaining the observed effects; but it appears to be satisfactory without calling for any additional assumptions.

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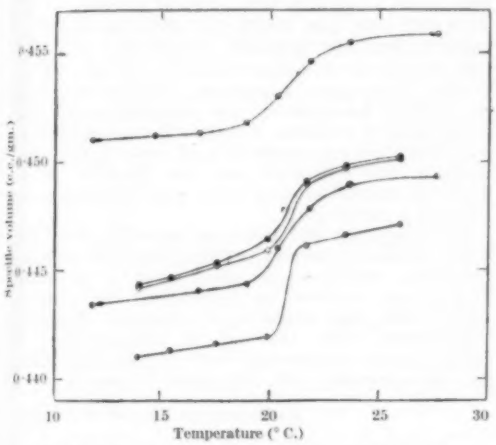
A Room-Temperature Transition in Polytetrafluoroethylene

In the course of determinations of the variation of the specific volume of polytetrafluoroethylene with temperatures between − 30° and + 360° C., a phenomenon was observed at about 20° C. which is, to the best of our knowledge, unique in the polymer field. Below 15° and above 25° C., the cubical coefficients of expansion are roughly the same and of the order of 3×10^{-4} c.c./c.c./° C., but at about 20° C. there is a 1 per cent increase in volume; data for five different samples of polytetrafluoroethylene are presented in the accompanying curves. The results for any single sample are reproducible, and the same curve is obtained on approaching the transition region from low and high temperatures.



Specific volume *vs.* temperature for polytetrafluoroethylene

The variation in specific volume from sample to sample is presumably due to their different degrees of crystallization, these being dependent upon the past thermal history of the specimens. The time required to attain equilibrium at temperatures in the transition region is of the order of two hours. The process is therefore quite slow.

This phenomenon is definitely not a 'second-order transition', as this would be characterized by a change in a first derivative only, in this case that of the specific volume, that is, the coefficient of thermal expansion. Moreover, it is thought that 'second-order transitions' are associated with changes in the amorphous regions of polymers[1], whereas the X-ray evidence given below suggests that this phenomenon is associated with a change in the crystal structure of polytetrafluoroethylene.

The initial measurements were made using a glass dilatometer, mercury being the enclosing liquid. The results presented were obtained by determining the densities of the samples by flotation in methyl iodide–chloroform mixtures, the densities of the mixtures being measured with a pyknometer.

X-ray diffraction photographs of the specimens taken above and below 20° C. show that a reversible change in the diffraction pattern takes place; reflexions from crystal planes parallel to the chain axis remain sharp and unchanged in relative intensity, though slightly changed in position, while those from planes inclined to the chain axis either become weaker and diffuse or disappear altogether. There is evidently a change of crystal structure; it is, however, not a change from one precise arrangement to another, but a change from three-dimensional (fully crystalline) order below 20° C. to a lower degree of order above 20° C. The chain repeat distance (2·62 A.) remains unchanged; but there is an increase of about 0·5 per cent in the side spacings at the transition point. This means an increase of specific volume of the crystals of about 1 per cent. It therefore appears that the 1 per cent increase in volume found by density measurements is due to this change of crystal structure, and not to any change in the amorphous regions or to a change in the proportions of crystalline and amorphous regions.

The observed changes in the diffraction pattern can be accounted for by a gain in freedom of position of the molecules by movement along their chain axes, the small increase of side-spacings being a by-product of this longitudinal freedom. Although a detailed picture can only be given when the crystal structure below 20° C. is fully determined (a problem on which we are now working), it may be said that the unit cell is either monoclinic or triclinic, and that the spreading of certain reflexions above 20° C. represents a variation of unit cell angles of several degrees. Whether this is a static variation from one crystal to another or a dynamic variation cannot be determined from X-ray results, though the former seems more likely. This variation of unit-cell angles means that, with respect to a given molecule, a neighbouring molecule may occupy a range of positions along its chain axis varying by something like 0·5 A. This is one-fifth the chain repeat-distance. It is remarkable that such a transition occurs so far below the melting point (330° C.).

The X-ray diffraction pattern above 20° C. is similar in type to those of shock-cooled polyamides[2], but in the polyamides the disorder is not associated with a definite temperature of transition, and can be removed by annealing.

The results of a detailed investigation of the behaviour of polytetrafluoroethylene over the wider temperature range will be published elsewhere.

We are indebted to Mr. R. P. Palmer for taking the X-ray photographs, and to Miss M. Lidderdale for carrying out many of the density determinations.

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Raman and Infra-Red Spectra of β-Quartz

The Raman spectrum of β-quartz has been investigated by Narayanswami[1]. He finds that the frequency 466 of α-quartz appears at 452·5, whereas the frequencies 207, 356 and 1,082 of α-quartz are absent from the spectrum. He also finds frequencies at 97, 250, 395, 686, 792, 1,060 and 1,154 cm.$^{-1}$, which correspond to the doubly degenerate frequencies 128, 265, 395–403, 695, 795–807, 1,063 and 1,159 of

α-quartz. These facts find a ready explanation on group theoretical considerations, and in addition we can predict corresponding results for the infra-red spectrum.

The unit cell in β-quartz contains six silicon and six oxygen atoms, each silicon atom being linked to two cells. This corresponds to the molecular formula $3SiO_2$. In order to analyse the vibrations of this system which give rise to the Raman spectrum of the first order, it is necessary to assume that the vibrations of atoms within a cell of crystal lattice have exactly the same frequency and phase as the vibrations in the neighbouring cells. This is immediately satisfied if we use the condition that the equivalent points of the lattice have the same displacement at any given instant, that is, those vibrations will not be permitted in which these atoms are moving in opposite phases. Considering, therefore, the group of six silicon and six oxygen atoms in the unit cell, we should have thirty-six modes of vibrations. But due to the restriction mentioned above, nine are forbidden, leaving twenty-seven modes which correspond to the modes of vibration of the group $3SiO_2$.

β-Quartz is hexagonal (point group D_6), and it possesses a six-fold axis of symmetry and six two-fold symmetry axes. The spectrum is therefore divided into six classes, A, B, C, D, E_1, E_2, the number of modes in these classes being 1, 2, 3, 2, 4, 4, respectively. Class A is totally symmetric and E_1, E_2 are doubly degenerate. Class A is active in Raman effect only, B in the infra-red only, C and D are forbidden in both, E_1 is active in both, and E_2 active only in the Raman effect.

The modes of vibration of α-quartz have been studied by Saksena[2]. This crystal belongs to point group D_3 and has only a three-fold axis of symmetry. There are only three classes—one totally symmetric containing four frequencies, namely, 207, 356, 466, 1,082, one anti-symmetric containing four frequencies, 1,149, 508, 777, 364, and one doubly degenerate containing the frequencies mentioned in the first paragraph. As the vibrating unit in α- and β-quartz is the same, their symmetry modes will be similar. Considering the totally symmetric class of α-quartz, we see that only the mode 466 can remain in the totally symmetric class of β-quartz, due to its being symmetric with respect to the six-fold axis, while the remaining three which are anti-symmetric to the six-fold axis have to go to class C of β-quartz. These are forbidden in both Raman and infra-red spectra. For the same reason the four anti-symmetric modes of α-quartz split into two classes B and D in β-quartz. The two modes having frequencies 508 and 1,149 in α-quartz go to class B due to symmetry with respect to the six-fold axis and should appear in the infra-red in β-quartz. The remaining two modes having frequencies 777 and 364 in α-quartz go to class D, due to being anti-symmetric to the six-fold axis, and are forbidden in both Raman and infra-red spectra. Thus we have one mode in class A, two in class B, three in class C, and two in class D of β-quartz, as is also found from the character table. We also see that degenerate modes of α-quartz will go to the two degenerate classes of β-quartz, both of which are Raman-active.

We are thus able to explain the results of Narayanswami that the frequencies 207, 356, 1,082 are not obtained in the Raman spectrum of β-quartz. Secondly, we can also explain the observed fact that all the degenerate Raman frequencies of α-quartz appear in β-quartz. We further see that the infra-red frequencies 1,149 and 508 of α-quartz will appear in the infra-red for β-quartz, while the two frequencies 777 and 364 will be forbidden in the infra-red. The frequencies coming in class E_2 of β-quartz are 1,060, 686, 479, 250, and these will be forbidden in the infra-red, while the frequencies 1,154, 792, 395, 97 should appear in both. The infra-red studies of β-quartz have not yet been made.

We have also calculated the frequencies of β-quartz. Using only four force constants, namely, K of Si—O valence, K_1, K_2 of Si—C—Si and O—Si—O deformation and K_3 of O—O repulsion, and giving them approximate values of $K = 5{\cdot}0 \times 10^5$, $K_1 = 0$, $K_2 = 2 \times 10^{-11}$, and $K_3 = -1 \times 10^5$ dynes, we have calculated the frequencies for the different classes. They are as follow: class A 537 [453]; class B 1,149, 392 (1,149, 508); class C 1,125, 311, 0 (1,082, 356, 207); class D 814, 273 (777, 364); class E_1 1,156, 891, 353, 50 [1,154, 792, 395, 97]; and class E_2 952, 499, 367, 275 [1,060, 686, 479, 250]. The frequencies in square brackets are the observed Raman frequencies of β-quartz, and the frequencies in ordinary brackets are the infra-red and Raman frequencies of α-quartz. Considering the approximate values of the force constants used, there is fair agreement in the calculated and the observed values, which lends good support to the analysis made in the preceding paragraph.

The frequency 207 becomes zero with these four force constants. As all the important force constants have been considered, its value must be very small. It has been observed by Nedungadi[3] and Narayanswami that this frequency in α-quartz diminishes considerably with the rise of temperature. Its diminution to a very small value in β-quartz is therefore in agreement with the observed results.

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Discontinuous Flow Phenomena in Gelatine Gels

Relaxation phenomena in gelatine solutions were first studied by Schwedoff[1] (1889), who found a relaxation of applied stress of the form

$$F - F_y = (F_0 - F_y) \exp(-t/\tau), \qquad (1)$$

where F is the stress at time t, F_0 is the initial stress, F_y is the residual stress, and τ is the relaxation time.

This corresponds to a stress v. rate of shear relation of the form

$$F - F_y = \eta_p G, \qquad (2)$$

where F is the stress, F_y is the yield value, η_p is the viscous coefficient, and G is the rate of shear.

Hatschek and Jane[2] were unable to confirm Schwedoff's equation, either for gelatine or anything else, and more recently Berglund[3] has attempted to discount Schwedoff's work entirely by viscosity

measurements on gelatine solutions in capillary viscometers and the fitting of Schwedoff's data into a log–log equation.

Relaxation phenomena in gelatine gels were examined in this laboratory in a coaxial cylinder (Couette type) viscometer which was fitted for the measurement of optical birefringence. The extinction angle and double refraction in the gels were followed simultaneously with the mechanical relaxation of stress.

In all cases a phenomenon was observed which has not hitherto been recorded. This was a discontinuous change in the flow properties during the course of the relaxation; this was clearly shown, not only in the actual relaxation curve, where it was not always very marked, but also in the extinction angle and double-refraction curves, where sharp changes occurred also. Typical curves are given in Figs. 1 and 2. Experimental points are not given on the stress relaxation curve as they were very numerous, and did not deviate from the line drawn through them.

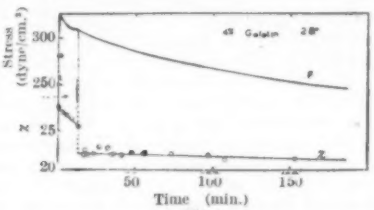

Fig. 1

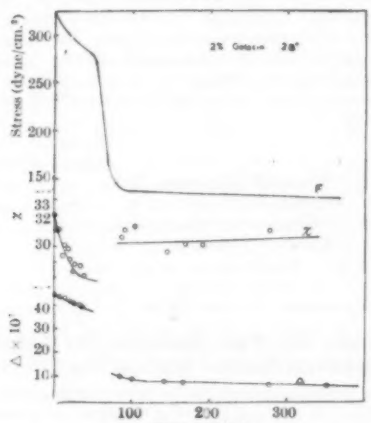

Fig. 2

χ is the extinction angle in degrees; Δ is the double refraction, $n_a - n_b$

It was found that the first part of the curve (the duration of which was from a few seconds to a week, depending on the temperature and concentration) obeyed Schwedoff's equation accurately. Moreover, the viscosity coefficient of plastic flow η_p in equation (2) was almost constant over a wide range of concentration and temperature. Then suddenly, at a certain point, the flow behaviour changed completely. This was a mechanism[1] which had no yield value and which obeyed Maxwell's law of stress relaxation in cases where the relaxation was fairly slow,

$$F = F_0 \exp(-t/\tau). \qquad (3)$$

The stress *v.* rate of shear relation was linear, that of a Newtonian liquid.

In some cases (Fig. 2) the second flow mechanism led to such a rapid relaxation of stress that steady flow conditions were never established before the third mechanism intervened, and only an approximate value of the Newtonian viscosity coefficient η could be obtained. In certain cases the change from one flow mechanism to the other was most striking. Thus for a 2 per cent gelatine gel at 25°, the relaxation was very slow over a period of three days, and a scale deflexion change of a few millimetres only was recorded. Then suddenly, within a few seconds, the whole stress relaxed towards zero, like a delayed action fuse.

The Newtonian viscosity coefficient η was markedly dependent on conditions, and was diminished considerably by a fall in concentration or a rise in temperature.

A third mechanism intervened towards the end of the experiment. This was a setting of the material before reaching zero stress. This leads to an increase in relaxation time towards the end of the experiment, which has often been recorded (for example, by Schofield and Scott Blair[4]) for other materials, and is the well-known phenomenon of 'frozen stress' found by Hatschek[5] for gelatine gels.

On examination of the curves given by Hatschek and Jane[2], it was discovered that at least half of them display experimental points which correspond closely to a curve of the type shown in Fig. 1, though the authors drew smooth curves through their data. It therefore seems that the phenomena noted here are not confined to gelatine but are generally applicable to certain colloidal systems.

These observations show that, for certain colloidal systems at least, flow mechanisms under a single simple set of experimental conditions are themselves simple; but they are a product of those conditions, and with a change in conditions they may change entirely. This is in contradiction to the treatment of flow properties in high polymers[6], where a complex series of combined flow elements is taken to represent the flow properties of the material under all experimental conditions. This approach may apply where molecular aggregates have a more or less permanent size and shape; but in most colloids, where aggregation and interactions may be continually changing, it seems that the formidable array of springs and dashpots can never represent the behaviour of the material in all circumstances, as their 'constants' will change with conditions.

Further details of these experiments will be the subject of a forthcoming publication. I am indebted to Dr. D. G. Dervichian for his supervision of this work.

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Use of Aspherical Surfaces in the Design of Magnifiers for Binocular Vision

During recent years, renewed and increasing interest has been shown in the use of aspherical surfaces as a means of improving the performance of optical instruments, and one notable application has been to low-power singlet lenses for industrial inspection purposes. Nevertheless, to the best of our knowledge, no serious attempt has hitherto been made to correct these lenses for binocular vision, and as a result of extensive experiments in this connexion it is now clear that a major contribution to the comfort of the user of such lenses over prolonged periods can be made by designing primarily for binocular viewing. It is proposed to publish a more detailed account of this investigation elsewhere; but in the meantime some notes on the more important features of the design may be of interest.

Most designers stress the necessity for freedom from distortion as being the most desirable property of a low-power magnifier. This is at first sight true; but there is, in fact, a defect of much greater significance, not immediately apparent to the user, but which produces to a greater or lesser degree headache, eye-strain and double vision. Take the case of a 6-in. focus lens of 4½-in. aperture and having spherical surfaces of radii 7⅛ in. and 5 in. Such a lens is shown in Fig. 1, the section being so chosen as to include the axis of the lens and both eyes, this being the simplest case to discuss as it avoids the use of skew rays. This particular 'bending' of the lens is chosen for various reasons which need not be considered here. An eye relief of 5 in. is also selected for certain reasons, and it will then be found that for most observers a working distance of about 3 in. from the lens will automatically be assumed, because the virtual image will be formed at about 14 in. from the eyes, that is, at a rather greater distance than the least distance of distinct vision. We now consider the *images* of the section of a plane object as seen by each eye separately and by both eyes taken binocularly.

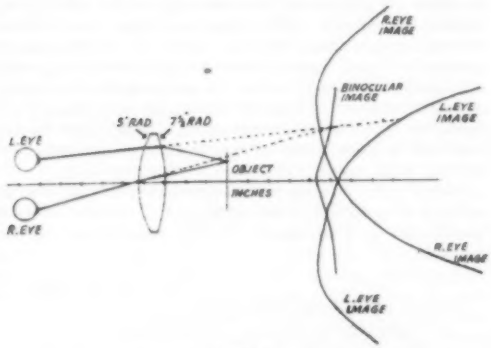

Fig. 1

These may be determined either trigonometrically or by direct measurement, and are also shown in Fig. 1. A more thorough investigation in which the entire object surface is considered indicates that the section chosen is, in general, that which exhibits the greatest amount of aberration and therefore it provides an adequate basis for further computations.

From an examination of the curves shown in Fig. 1 it will be apparent in particular that, as the edge of the field is approached, a rapidly increasing separation exists between the two monocular fields, and it will thus be clear that the normal relation between accommodation and convergence must be upset seriously.

Another point to observe is that, due to vignetting, the monocular fields extend considerably beyond the binocular field. In Fig. 1 it will be seen that a sharp discontinuity of viewing conditions will occur at the edge of the binocular field, thereby adding to the discomfort experienced by the user.

By aspherizing one or both surfaces suitably, much can be done to remedy these defects as well as to correct distortion and other optical aberrations, and the curves of Fig. 2 are self-explanatory.

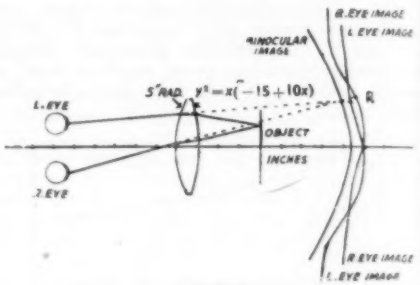

Fig. 2

This result has been achieved by using a conic to generate the surface remote from the eyes, its equation in Cartesian co-ordinates being $y^2 = x(-15 + 10x)$ using the usual sign conventions.

Needless to say, the best results cannot be achieved by restricting the design to conics, and details of lenses employing higher-degree curves will be given elsewhere.

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Life-time for Pair Emission by Spherically Symmetrical Excited State of the O^{16} Nucleus

In a previous note[1], we reported measurements of the relative probability of emission of electron-positron pairs from the excited state of O^{16} at 5·9 MeV. as a function of the angle between directions of emission of positron and electron. The results of these measurements are, at least approximately, in agreement with the assumption that the transition occurs between two states of the O^{16} nucleus with zero angular momentum and even parity, and is essentially electromagnetic in nature. The absolute probability (that is, the life-time) of such a transition depends on more detailed properties of the two nuclear states involved, although the indication that the process is of an electromagnetic type suggests a value more closely comparable[2] with the short life-times for γ-radiative transitions, rather than the longer times typical of β-decay processes.

We have made measurements of the life-time which confirm this expectation. In a first series of experi-

ments, aimed at establishing an order of magnitude only, we attempted to measure the life-time by bombarding a fluorine target with a pulsed beam of protons (pulse duration of between 10^{-6} and 5×10^{-7} sec.), detecting the electron-positron pairs from the O^{16} nucleus (produced by the reaction $F^{19}(p,\alpha)O^{16}$) by means of Geiger counters, and investigating whether the emission of the electrons was simultaneous with bombardment of the fluorine target. We were unable to detect any time-delay between the bombardment and the emission of electrons, apart from the inevitable random delays associated with Geiger counter detection, and we concluded that the life-time was much less than 10^{-6} sec.

In the second series of experiments we utilized the fact that the excited O^{16} nucleus produced in the reaction $F^{19}(p,\alpha)O^{16}$ recoils with an initial velocity (slightly dependent on the direction of motion) of about $2{\cdot}6 \times 10^{8}$ cm./sec. We bombarded with protons a thin (3×10^{-5} gm./cm.^{2}) layer of calcium fluoride deposited on a plane solid surface, and by a suitable arrangement of apertures we detected only those electrons and positrons which came from O^{16} nuclei which had moved more than a prescribed, but variable, distance from the plane of the target in the direction away from the solid backing material. From the work of Blackett and Lees[2] on the ranges of recoiling nuclei, we could estimate the small (about 10 per cent on the average) reduction in velocity of the O^{16} nuclei in traversing part of the calcium fluoride layer. We were able to estimate the mean distance travelled by the excited O^{16} nuclei between the instant of their formation and the emission of electron-positron pairs as 0·18 mm. This corresponds to a mean life of 7×10^{-11} sec. The accuracy of the measurements is about 10 per cent, apart from an uncertainty of the same order due to the assumption that α-particles in the primary reaction are emitted isotropically.

The simplest way of relating this result to the properties of the two states of the O^{16} nucleus is to regard the nucleus in both states as a uniformly charged sphere, and uniformly dilated in the state of higher energy. With such a model the life-time would be related to the degree of dilation, and can be used to provide an estimate of the nuclear compressibility. An alternative model, representing approximations of an opposite kind, is the simple α-particle model in which the O^{16} nucleus is represented as four α-particles at the vertices of a regular tetrahedron, and the excited state at 5·9 MeV. associated with the first, spherically symmetrical vibrational mode of oscillation. Detailed calculation[3] indicates that with the first ('liquid-drop') model the measured life-time yields a value for the nuclear compressibility of the same order of magnitude as that deduced from other nuclear data[4]. With the α-particle model, on the other hand, the life-time is several orders of magnitude larger than predicted on the basis of the usually assumed properties of this model.

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Subsurface Crypts, Oogenesis, and the Corpus Luteum in the Ovaries of Seals

Examination of a series of the reproductive organs from three species of antarctic seals, collected by the members of the Falkland Islands Dependencies Survey, has brought to light several interesting phenomena in the ovaries of the Weddell seal (*Leptonychotes weddelli*), the crab-eater seal (*Lobodon carcinophagus*) and the leopard seal (*Hydrurga leptonyx*).

Macroscopic inspection of the ovaries of these species reveals nothing unusual, the surface appearing more or less smooth and but slightly raised over the larger follicles and corpora lutea. However, microscopic examination of sections shows that there is an extensive and peculiar development of crypts below the surface. At irregular intervals the germinal epithelium dips down into the peripheral ovarian stroma, forming a tube with a conspicuous lumen. On reaching a level just deep to the tunica albuginea, the tubes curve through a right angle to continue their course parallel to the surface of the ovary and, increasing in lateral width, form extensive crypts undermining the outer layer of the ovary. The germinal epithelium, in dipping below the ovarian surface, takes a lamina of the tunica albuginea with it, so that the floor as well as the roof of the crypts contains a stratum of this tissue. In many places the lumina of the crypts are crossed by epithelial pillars which consist of two layers of germinal epithelium, sometimes enclosing a small strand of tunica albuginea. In some ovaries the pillars are so numerous, and the crypts so tortuous, that they appear much subdivided. If, in addition, the pillars are of more than moderate thickness, the crypts appear as a large number of irregular spaces beneath the outer lamina of the tunica albuginea. In many instances the smaller crypts, and diverticula of the larger ones, are found to terminate as primary follicles, the epithelium surrounding the oogonia being directly continuous with the germinal epithelium lining the lumina of the crypts.

In the early stages of the formation of primary follicles, epithelial cells migrate from the lining of the crypts and form the granulosa cells surrounding the oogonia. It is not yet clear whether the oogonia arise directly from the epithelium of the crypts or whether they have reached their position previously from some other source.

In ovaries with widespread crypts, the outer layer of the tunica albuginea, bounded on its internal and external faces by germinal epithelium, gives the appearance of a separate capsule enclosing the ovary and connected to it only by slender and scattered epithelial strands. On examining the ovaries of the common seal (*Phoca vitulina*), the grey seal (*Halychœrus grypus*), and of the southern sea-lion (*Otaria byronia*), a similar, though less extensive, system of crypts was found.

The size and extent of the crypts and the proliferation of the epithelium appear to be related to reproductive activity. The ovaries of antarctic seals killed in September and early October show slight, narrow crypts with little cellular activity. However, seals killed during the period between late October to early February show extensive and active crypt formation. During middle and late pregnancy, both in antarctic and northern seals, the activity of the process is decreased.

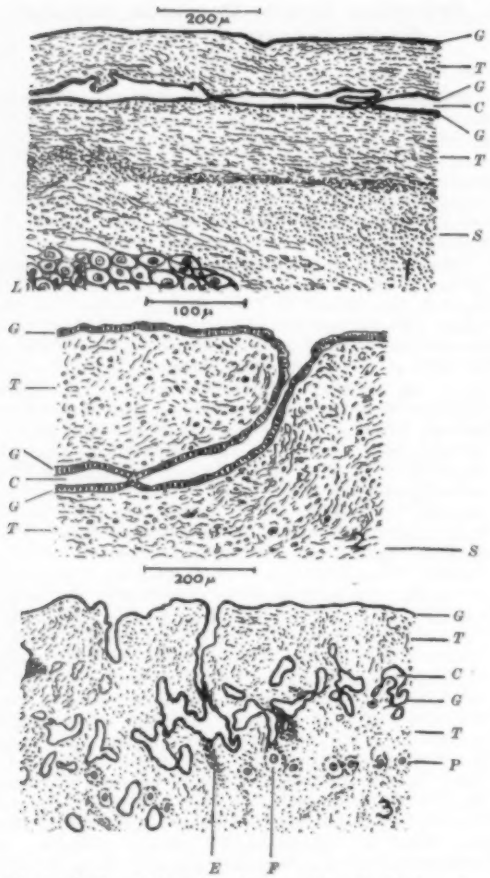

Fig. 1. Section of the ovary of a crab-eater seal, showing subsurface crypt lined by germinal epithelium

Fig. 2. Section of the ovary of Weddell seal, showing the mouth of the subsurface crypt

Fig. 3. Section of the ovary of Weddell seal, showing subsurface crypts of irregular shape and germinal epithelium in direct continuity with the epithelium of a primary follicle

C, crypt; *E*, cord of cells derived from germinal epithelium; *F*, primary follicle, the epithelium in direct continuity with the epithelium of a crypt; *G*, germinal epithelium; *L*, part of a corpus luteum; *P*, primary follicles; *S*, stroma; *T*, tunica albuginea

Signs of crypt formation in the fœtal ovary are first seen at the 18-cm. stage in a Weddell seal fœtus. Marked invagination of the epithelium is occurring near the hilum of the gonad to form crypts and diverticula similar to those found in the adult ovary. The ovaries of near-term fœtuses and immature specimens of the common seal show extensive crypt formation and proliferation of the invaginated epithelium beneath the tunica albuginea in relation to precociously formed fœtal oocytes. Figs. 1, 2 and 3, traced from photomicrographs, show the form and relationships of the crypts in adult Weddell and crab-eater seals.

The granulosa layer of the maturing follicles is thrown into folds reminiscent, in a lesser degree, of those in the dog and the fox. The theca interna layer is well developed and shows evidence of cellular activity. During the early weeks in the life of the corpus luteum, when delay in implantation of the blastocyst probably occurs, the gland is large, with remnants of a central cavity. Vascularization has progressed only slowly, and the luteal cells show marked cytoplasmic vacuolation. The theca interna cells, which are also vacuolated, are arranged in groups at the periphery of the gland and in relation to the short connective tissue trabeculæ.

After implantation, the gland becomes very vascular and hyperæmic, the luteal and theca interna cells lose their vacuoles and their cytoplasm shrinks. By the time the embryo is 70 mm. in length, the corpus luteum shows evidence of early retrogression in that the luteal cells are small and shrunken, the connective tissue has increased greatly in amount and the theca interna cells have almost disappeared. Such retrogressive or transitional changes are first seen in parts of the gland when the embryo is 22 mm. in length, and they are probably related to the development and activity of the placenta.

Fuller details on these points will be published elsewhere in due course, together with the results of our other studies on reproduction in seals.

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Magnetic Storms and Cosmic-Ray Intensity

During February–April 1947, which was a period of pronounced solar activity, we kept, at Lahore, hourly observations of the cosmic-ray intensity during the day-time with the view of studying its possible correlation with changes of magnetic intensity. Cosmic-ray intensity was measured with a triple counting vertical telescope[1], the counts per minute being corrected for the pressure and temperature variations obtained from meteorological data. Hourly values of H were obtained from the nearest magnetic observatory at Alibag (Bombay) and are given in terms of gamma ($1\gamma = 10^{-5}$ gauss). A plot of the mean day-time values determined for the same hours for cosmic-ray and magnetic intensity showed a marked variation of each, during magnetic storms; but in general over the period of almost two months the correlation coefficient between I and H shows a slight positive tendency, though we find it to be below the statistically significant level. This might possibly be due to the fact that the magnetic changes and cosmic-ray intensity changes at two widely different stations during magnetically quiet or slightly disturbed days may not be correlated, while the changes during strong storms might be observed simultaneously even at different stations, sometimes all over the world[2,3].

During storms on February 16 and March 2, 1947, horizontal magnetic intensity changed by 135 and 253 gamma during a period of nearly four hours, and our observations over the same hours show large changes in cosmic-ray intensity. The variations of the cosmic-ray intensity in relation to the magnetic disturbance expressed as $\Delta I/I\,\Delta H$ and $H\,\Delta I/I\,\Delta H$ in order of magnitude come out to be $+0{\cdot}097 \pm 0{\cdot}031$ per cent/γ and $+38{\cdot}3 \pm 12{\cdot}3$ in the storm occurring on March 2, and $-0{\cdot}103 \pm 0{\cdot}060$ per cent/γ and $-39{\cdot}7 \pm$

23·0 in the storm on February 16. The values correspond with those reported by others, though the error in our case is somewhat larger.

It is remarkable that during the magnetic storms the cosmic-ray intensity and magnetic intensity variations may possess in some cases positive and in others a negative correlation, as has been found by other scientific workers. A complete account of our observations will be published elsewhere.

We are grateful to Dr. Alexandar Wolsky, chief scientific officer, Unesco, for obtaining meteorological observations from Pakistan, and to the director of the Colaba and Alibag Observatories for supplying us with detailed magnetic data necessary for the calculations.

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Discovery of Neolithic Polished Bone Axe-Heads in Africa

An early occupation site at Esh Shaheinab on the west bank of the Nile about thirty miles north of Omdurman was excavated under the auspices of the Sudan Government Antiquities Service in January and February 1949. Polished stone axe-heads, gouges, chisels and planes, small disk beads of amazon-stone, and serrated bivalve shells show that the culture was closely connected with that of the Fayum Neolithic a thousand miles to the north. The type of settlement was also similar, with numerous hearths but no other trace of houses, and no burials in the settlement.

The most important discovery, however, was one that throws important light on the development of the handled axe. Eleven polished axe-heads made from the long bones of large mammals, together with sixty-five fragments of similar tools, were found associated with a comparable number of normal stone axe-heads. Both forms of axe-head were contemporary, specimens of each occurring together in the same hearth. The bone axe-heads vary in length from 194 mm. to 66 mm., and in width from 70 mm. to 33 mm., the average length being 131 mm. and the average width 43 mm. They have been narrowed slightly at the butt end, presumably for insertion into a wooden handle, and have been given a sharp cutting edge at the broad end by being rubbed, no doubt on one of the many sandstone grinders which abounded on the site, and which were usually used for grinding red ochre.

Though generally smaller than the bone axe-heads, some of the stone axe-heads were the same size as the bone specimens. Some of them had been only chipped, but others had been polished by rubbing as well at the cutting end, to an extent similar to the rubbing on the bone axe-heads.

It seems difficult to avoid the conclusion that these bone axe-heads are the prototype of the stone ones. The inhabitants of the site appear from the animal remains to have been hunters who killed large animals, including hippopotamus, rhinoceros and elephant. Probably large splinters of bone were used for hacking meat off the kill, the next step being to fit such a splinter into a wooden handle, thereby making a more efficient hacking tool. It would not be a difficult further step, for people who were using sandstone grinders for ochre, to give the new tool a sharp edge on a sandstone rubber. (Indeed, I am reminded by Dr. K. P. Oakley that the shaping of bone tools on a rubbing stone was not an unknown technique in Africa in pre-Neolithic times.) Having thus invented the axe, they probably transferred its use from meat to wood, for the gouges, of which nearly two hundred were found, must have been used for working wood, perhaps in making dug-out canoes and spear-throwers. When they discovered that a bone axe-head was not strong enough to cut any but the softest woods, it would be an obvious step for them to copy the bone axe-head in stone, and so the chipped and partly polished stone axe-head would be invented.

A full report of the excavation will be published at the first opportunity. In the meantime, it is of interest to report that another novel feature at Esh Shaheinab was a notched fish-hook made from bivalve shell, which may be ancestral to the perforated shell fish-hook of the Badarian; and also that the pottery was derived from that of the Khartoum Mesolithic[1] and includes what must be the earliest black-topped red ware known in the Nile Valley.

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May 30.

[1] See "Early Khartoum" (Oxford University Press, 1949).

Thermal Conductivity of Powders

According to a note in *Physical Abstracts*[1], R. L. Mullokandov[2] finds that thermal conductivity of powders is practically due only to the convection in the surrounding gas, and that hence "a layer of smooth spherical particles in vacuum may be used as a good thermal insulator". This was discovered by M. Smoluchowski some forty years ago[3]. He investigated both theoretically and experimentally the thermal conductivity of powders, and concluded that filling the space between the walls of a Dewar vessel with a suitable powder would provide improved insulation by reducing the convective currents as well as the radiation and, moreover, would improve the vacuum by absorption. His application for a patent resulted in a long argument with the German Patent Office, whose examiners were reluctant to admit that any material agent could provide a better insulation than 'absolute' vacuum. At that time a large metallic Dewar vessel with its interstice filled with powdered active carbon was built at the Physical Institute of the University in Lwów, and showed the expected high insulating properties. As that work of Smoluchowski remained little known, I think that this information may be of interest.

Z. Klemensiewicz

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[1] *Phys. Abstr.*, 1432 (1949).
[2] *J. Tech. Phys., U.S.S.R.*, **17**, 1149 (1947).
[3] *Bull. Int. Acad. Cracovie*, 129 (1910), and *7SS* II Intern. Kaltekongress (Vienna, 1910).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, October 3

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. Constantinesco: "Scientists *v.* Engineers".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. J. Grant: "Pulp and Paper Manufacture as a Chemical Industry".

Monday, October 3—Wednesday, October 12

INSTITUTE OF METALS (at the Maison de la Chimie, 28 rue St. Dominique, Paris).—Forty-first Annual Autumn Meeting.

Tuesday, October 4

CHADWICK PUBLIC LECTURE (at the Art Gallery, New Walk, Leicester), at 4.30 p.m.—Mr. Asa Briggs: "Public Opinion and Public Health in the Age of Chadwick".*

Tuesday, October 4—Wednesday, October 5

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Science Museum, Exhibition Road, London, S.W.7), at 10.30 a.m.—Theoretical Colloquia.

Wednesday, October 5

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (in the Electrical Department, The University, Glasgow), at 6.30 p.m.—Mr. A. L. Whitwell: "Electronics in Aircraft Design".

SOCIETY OF CHEMICAL INDUSTRY, BIRMINGHAM AND MIDLAND SECTION AND PLASTICS AND POLYMER GROUP (in the Medical Theatre, The University, Edmund Street, Birmingham), at 6.30 p.m.—Prof. H. W. Melville, F.R.S.: "Co-polymerization and related Phenomena".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.45 p.m.—Mr. J. Straub: "The Calculation of the Botanical Composition of Wheat Flours and Offals from the Chemical Analysis"; Dr. D. W. Kent-Jones and Mr. W. Martin: "A Photo-electric Method of Determining the Colour of Flour as affected by Grade, by Measurements of Reflecting Power"; Dr. D. W. Kent-Jones, Dr. A. J. Amos and Mr. W. Martin: "Experiments in the Photo-electric Recording of Flour Grade by Measurements of Reflecting Power".

BRITISH INSTITUTION OF RADIO ENGINEERS, MERSEYSIDE SECTION (in the Accountants' Hall, Derby Square, Liverpool), at 7 p.m.—Mr. L. H. Bedford: "The Sensitivity and Other Properties of Television Camera Tubes".

Thursday, October 6

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Architectural Association, 34–36 Bedford Square, London, W.C.1), at 10.30 a.m.—Discussion on "Acoustical Practice in Auditorium Design".

ASSOCIATION OF APPLIED BIOLOGISTS (at the Imperial College of Science and Technology, South Kensington, London, S.W.7), at 2 p.m.—Papers on "Virus Diseases of Trees".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. E. B. Moullin: Inaugural Address.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. P. M. S. Blackett, F.R.S.: "Some Recent Advances in Cosmic Ray Research".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. I. Driggs: "Aircraft Design Analysis Methods as employed by the Research Division of the Bureau of Aeronautics, U.S. Navy Department".

SOCIETY OF CHEMICAL INDUSTRY, NOTTINGHAM SECTION (at the Gas Showrooms, Nottingham), at 7.15 p.m.—Mr. G. N. Hodson: "The Use of Ceramics in Chemical Industry".

Friday, October 7

PHYSICAL SOCIETY (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. H. Kolsky: "An Investigation of the Mechanical Properties of Materials at Very High Rates of Loading".

Friday, October 7—Sunday, October 9

ROYAL SOCIETY FOR THE PREVENTION OF ACCIDENTS, on behalf of the Association of British Chemical Manufacturers (at the Royal Hotel, Scarborough).—Conference on Industrial Safety.

Saturday, October 8

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at Holly Royde, 30 Palatine Road, Withington, Manchester), at 2.45 p.m.—Prof. S. Dobrin: "Pushkin, a Witness for Russia".

Saturday, October 8—Wednesday, October 26

ROYAL PHOTOGRAPHIC SOCIETY (at 16 Princes Gate, London, S.W.7), at 10 a.m.—Ninety-fourth Annual Exhibition of Photography, Part 2: Scientific, Nature, Record and Technical Exhibits.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST IN THE VETERINARY RESEARCH DIVISION of the Ministry of Agriculture—The Director of Establishments, Ministry of Finance, Stormont, Belfast (October 11).

ANALYST IN THE CHEMISTRY DEPARTMENT, and a RESEARCH BIOCHEMIST as Assistant IN THE ANIMAL HUSBANDRY DEPARTMENT—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (October 12).

PRINCIPAL SCIENTIFIC OFFICERS and SENIOR SCIENTIFIC OFFICERS (with 1st or 2nd Class Honours degree in chemistry or physics, or equivalent, with suitable postgraduate experience in emission spectroscopy, electronic techniques, or physical chemistry) in the Ministry of Supply Chemical Inspectorate (Atomic Energy), and PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (with 1st or 2nd Class Honours degree in chemistry with experience in fundamental physical or inorganic chemistry research), and a SENIOR SCIENTIFIC OFFICER (with 1st or 2nd Class Honours degree in chemistry or physics, and research experience in X-ray crystallography), at the Atomic Energy Research Establishment, Harwell—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2794 (October 14).

PRINCIPAL SCIENTIFIC OFFICER, SENIOR SCIENTIFIC OFFICERS (2), SCIENTIFIC OFFICERS (2), a SENIOR EXPERIMENTAL OFFICER, and EXPERIMENTAL OFFICERS (4), in a Research and Development Branch at Salisbury, near Adelaide, of the Commonwealth of Australia Department of Supply and Development—The Australian Munitions Representative, Canberra House, 87 Jermyn Street, London, S.W.1 (October 15).

SHOP MANAGER (Development) to plan and supervise development work in connexion with filling of all types of ammunition (Ref. C.605/49BN), and a SHOP MANAGER (Engineering) to organise and manage general engineering shops engaged on factory plant maintenance (Ref. C.606/49BN), at a Ministry of Supply factory in Lancashire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 24).

PHYSICAL or INORGANIC CHEMISTS in the London area, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.697/49AA (October 28).

NATURAL HISTORY TECHNICAL ASSISTANT—The Keeper of the Museum, The Yorkshire Museum, York (October 31).

LECTURER IN BOTANY in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

OFFICER-IN-CHARGE, Underwater Research Laboratory, Auckland—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (October 31).

LECTURER IN CIVIL ENGINEERING (with special interest in Soil Mechanics and Reinforced Concrete) at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 1).

MATHEMATICIANS (with knowledge of statistical mechanics, gas kinetics and principles of gas dynamics) as Senior Scientific Officers under the Ministry of Supply in South-East England—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.230/49AA (November 3).

SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS at the Atomic Energy Research Establishment, Harwell, for (*a*) statistical work on activity, Hollerith and exposure records, and (*b*) routine and research work on health tolerances—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.236/49AA (November 4).

PROFESSOR OF CHEMICAL TECHNOLOGY, with special reference to Chemical Engineering—The Registrar, Indian Institute of Science, Bangalore 3, India (November 30).

RESEARCH OFFICER IN THE NATIONAL INSTITUTE FOR PERSONNEL RESEARCH, Johannesburg—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, November 30).

CHIEF ASSISTANT AT THE RADCLIFFE OBSERVATORY, Pretoria—The Secretary to the Radcliffe Trustees, 7 Lincoln's Inn Fields, London, W.C.2 (November 30).

LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary, Wye College, Wye, Ashford, Kent.

ASSISTANT PROFESSOR OF PHYSICAL CHEMISTRY—Prof. A. N. Campbell, Department of Chemistry, University of Manitoba, Winnipeg, Canada.

LECTURER IN BIOLOGY—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

LABORATORY TECHNICIAN—The Administrative Officer, Kingston General Hospital, Hull.

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